

AN ABSTRACT OF THE THESIS OF

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Title: An Examination of Students' Attitudes toward School and Classroom Science

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The purpose of this study was to examine fifth, seventh, and tenth graders' attitudes toward school and classroom science by means of questionnaires and interviews. In particular, the study hoped to determine (a) if a relationship existed between these two attitudes, (b) what relationship, if any, grade level, gender, ethnicity, school/community type, expected GPA and science grade, and personally satisfying GPA and science grade had with either or both of the attitudes, and (c) the source of students' attitudes.

The questionnaires used in this study (Science Attitude Scale for Middle School Students by Misiti, Shrigley, and Hanson and one constructed by the author) were found to be both valid and reliable. The surveys were administered to approximately 1,000 fifth, seventh,

and tenth graders from schools representing rural, small city, and urban communities at the commencement and near the end of the schools' fall terms. After the second administration of the questionnaires, 25 students, representing each grade level from each community type, were interviewed following a structured interview format.

The results indicated that while a statistically significant relationship did exist between students' attitudes toward school and toward classroom science, the relationship had no practical meaning. Females were slightly more positive about school than their male counterparts. No gender differences were found with respect to attitudes toward classroom science. Fifth graders held significantly more positive attitudes toward science than seventh and tenth graders. None of the other variables were found to have any practical relationship to either of the attitudes.

The interview data suggested that students from all three grade levels had definite feelings about school and classroom science, particularly about modes of instruction, relevancy, their teachers, and the effect of attitude on achievement.

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AN EXAMINATION OF STUDENTS' ATTITUDES TOWARD SCHOOL AND CLASSROOM SCIENCE

CHAPTER I. INTRODUCTION

There is much concern about the scientific literacy of the students who graduate from our high schools (Hanson, 1988). Accordingly, a strong emphasis is currently being placed on improving the quality of science education in the United States. The hope is that students will become more scientifically literate, thereby being better able as adults to deal with science-related political, societal, and personal issues.

One main hurdle educators must overcome in this endeavor is getting students to enjoy the sciences. In fact, one of the goals of Project 2061 (American Association for the Advancement of Science, 1989), an educational reform project, is for all students to possess a positive attitude toward science. It is thought that a student's attitude toward science may have an effect on a student's motivation, interest, and achievement in the sciences as well as enrollment in elective science courses and other science-related behaviors (Koballa & Crawley, 1985; Laforgia, 1988; Rennie & Punch, 1991; Shrigley, 1990).

The belief that attitude and behavior are related is supported by both the Theory of Reasoned Action (Ajzen & Fishbein, 1980) and the Theory of Planned Behavior (Ajzen & Madden, 1986). The Theory of Reasoned Action focuses on

a person's attitude toward a behavior rather than toward objects. It states that behavior can be predicted by behavioral intent. In turn, the strength of an intention is based on what the individual feels the outcomes of the behavior will be, how the individual feels about them (collectively comprising the person's attitude toward the behavior), and what others feel about the behavior and how important those people's beliefs are to the individual (the social pressure concerning the behavior, the subjective norm). The Theory of Planned Behavior takes the aforementioned theory one step further by adding the individual's perceived behavioral control as a variable that affects behavioral intent. Numerous studies have been conducted based on these models, the results of which have presented strong evidence in support of these theories (Crawley & Koballa, 1991; Koballa, 1988; Ray, 1991; Warden & Koballa, 1991, among others).

Although many of the studies done in the area of student attitudes toward science have been inconclusive, one particularly disturbing trend has emerged: a recurring pattern of decreasing attitude toward science with higher grade levels (Ayers & Price, 1975; Finson & Enochs, 1987; Levin & Fowler, 1984; Perrodin, 1966; Simpson & Oliver, 1985; Vanek & Montean, 1977; Yager & Bonnstetter, 1984; Yager & Penick, 1986). Barrington and Hendricks (1988) and James and Smith (1985) found a

decline from elementary grades to middle school, although they did not notice an attitude drop from middle to high schools. Only one study found that students' attitudes did not decline (Brunkhorst, 1988).

Curiously, a similar trend is seen in the research concerning students' attitudes toward school. The same pattern of decreasing attitude with increasing school experience is evident (Berliner & Casanova, 1985; Darom & Rich, 1988; Glick, 1970; Haladyna & Thomas, 1979). The research leads one to wonder whether there is a relationship between the increasingly negative attitudes of students toward school and toward science over time. Does the students' dislike of school rub off on their feelings toward science or are these attitudes independent?

Current theories on attitude development and attitude change accept the premise that beliefs provide the cognitive basis of attitudes (Petty & Cacioppo, 1981; Shrigley, 1990). Further, in order to effect a change in attitude, one's belief system must be modified (Ajzen & Fishbein, 1980; McGuire, 1960; Petty & Cacioppo, 1981; Wyer & Goldberg, 1970). "One popular approach to the structure of beliefs is to view them as existing in an interconnected syllogistic network" (Petty & Cacioppo, 1981, pg. 184). If humans are accepted as being rational, thinking beings, it would follow that their beliefs would

tend to be logically consistent. A syllogism that warrants examination is:

First premise: I dislike school.

Second premise: Science class is a part of school.

Conclusion: I dislike science class.

Three studies examined the relationship between attitudes toward school and attitudes toward courses. Jaus (1977) found that students' attitudes toward both school and science decline with time. Haladyna and Thomas (1979), on the other hand, found the usual decline in school attitude but felt it was unrelated to attitudes toward specific courses. Talton & Simpson (1986) reported there was no relationship between attitude toward school and attitude toward science. The question remains unresolved.

Statement of the Problem

Because attitudes may have a direct influence on achieving the national goals of science education, and because attitudes are learned and therefore presumably can be taught, students' attitude toward science is a topic that merits examination. Although many studies have been undertaken, much is still unclear and unknown about the formation of students' attitudes toward science.

If we are to improve the quality of science education in our country, new research on students' attitudes must

be undertaken. The more we learn about students' attitudes toward science, the better able we will be to graduate seniors who possess positive attitudes toward science. In this changing world, where science and technology play such a major role, it is imperative that our citizens develop healthy attitudes toward science.

An area that has received little attention by science education researchers is the relationship between students' attitudes toward school and students' attitudes toward science. Students' attitudes toward school and science appear to be shaped by the same factors: teachers, learning environment, self-concept, peers, parental influence, etc. (Glick, 1970; Haladyna, Olsen, & Shaughnessy, 1983; Jackson & Getzels, 1959). In both cases, attitude is believed to be related to students' achievement, motivation, interest, etc. (Glick, 1970; Jackson & Getzels, 1959). Both school and science curricula experience "drop-outs." Students in upper grades have less positive attitudes toward school and science when compared with students in lower grades. Because of the similarities in these attitudes, whether a relationship exists between attitude toward school and attitude toward science appears to be a basic question, and one that needs more careful investigation.

Science can be thought of as a subset of school. It seems logical that how one feels about a part may affect

that individual's feelings about the whole, and vice versa. Indeed, if students' attitudes toward science are correlated with students' attitudes toward school, methods used to improve the former (and, perhaps, the latter) need to be reassessed.

Specifically, this research was designed to answer the following:

1. Are students' attitudes toward science related to students' attitudes toward school?
2. Is the relationship between attitudes toward school and science different for varying populations: grade level, ethnicity, gender, type of school/community environment, self-reported school/science achievement, and student personal satisfaction with school/science achievement?
3. Regarding students' attitudes toward school:
 - a) Is grade level a significant factor?
 - b) Is ethnicity a significant factor?
 - c) Is gender a significant factor?
 - d) Does the type of school/community environment affect attitudes?
 - e) Is there a relationship between attitude and self-reported school achievement?
 - f) Is there a relationship between attitude and personal satisfaction with school achievement?

4. Regarding students' attitudes toward science:
- a) Is grade level a significant factor?
 - b) Is ethnicity a significant factor?
 - c) Is gender a significant factor?
 - d) Does the type of school/community environment affect attitudes?
 - e) Is there a relationship between attitude and self-reported science achievement?
 - f) Is there a relationship between attitude and personal satisfaction with science achievement?

Significance of the Study

The outcomes of this study are needed for two basic reasons: to add to and hopefully clarify the body of literature that presently exists, and to give some direction to the work on improving students' attitudes toward science. Few studies (Berk, Rose, & Stewart, 1970; Darom & Rich; Glick, 1970; Jackson & Getzels, 1959; Jackson & Lahaderne, 1967) exist that examine students' attitudes toward school. Any new information that can be added to the research base should be welcomed. Much of the research that has been done on students' attitudes toward science have presented conflicting data, particularly concerning gender and racial differences. Again, the research base is in need of additional input. Further, many of the studies that have been done used

instruments for which validity and reliability were either not reported or incorrectly determined. Because concern was placed on ensuring the validity and reliability of the instrumentation used in this study, the data gathered should be of greater use in examining the problem of students' attitudes. In addition, while a number of studies exist which examined attitude and achievement, none have considered the possibility of a relationship between attitude and student personal satisfaction with achievement.

The most important area of concern that this study should shed light on is the one that has been most neglected. Are students' attitudes toward school and science correlated? If the data suggest the two attitudes are related, science educators/researchers may be attacking the problem of improving students' attitudes toward science in a vacuum, making it less likely that their efforts will be successful. Indeed, if the two are correlated, the problem of students' attitudes toward science may be but a piece of a more global attitude problem. This would indicate that attitude change efforts need to be implemented by all subject area teachers, and perhaps using a different approach. Conversely, should it be found that no correlation exists between students' attitudes toward school and science, then science

educators/researchers would have more evidence to suggest excluding that variable from further consideration.

Discussion of Terms

It is necessary to define what is meant by "attitude," "attitude toward science," and "attitude toward school." Attitude is often confused with belief. Attitude is a bipolar evaluation; that is, favorable or unfavorable feelings toward something or someone. Attitudes are "temporary but stable; that is, they are enduring enough to be stable but transient enough to be changed" (Shrigley, Koballa, & Simpson, 1988). Attitude is based on a person's beliefs. Beliefs differ from attitudes in that beliefs are cognitive rather than affective in nature and are not bipolar.

Another common area of confusion is the differentiation between "scientific attitude" and "attitude toward science." "Scientific attitude" deals with cognition, the mental processes used by scientists. "Attitude toward science" pertains to the affective domain. For the purposes of this research, the phrase "attitude toward science" meant favorable or unfavorable feelings about science as a school subject. Further, for the purposes of this study, it was understood that many factors, including the science teachers and the particular science classes the students have had, will undoubtedly

have had an effect on students' attitudes toward science. The phrase "attitude toward school" pertained to how the student felt about school in general and the value of schooling. It was not concerned with measuring specific factors in the school environment such as one's teachers, the school administration, school subjects, or the classroom environment.

CHAPTER II. REVIEW OF THE LITERATURE

Introduction

Student attitude has been an area of concern in science education for at least three decades (Rennie & Punch, 1991). While a wealth of studies has been conducted, what is known about student attitudes toward science is quite limited. A number of studies has concentrated on determining the variables that affect the development of attitudes toward science (Diamond, St. John, Cleary, & Librero, 1987; Haladyna, Olsen, & Shaughnessy, 1983; Talton & Simpson, 1986; and others). Others have tried to develop or substantiate a model (Baker, 1985; Haladyna & Shaughnessy, 1982; Koballa, 1988; Rennie & Punch, 1991; and others). Some research was concerned with the relationship between attitude and achievement (Cannon & Simpson, 1985; Harty, Beall, & Scharmann, 1985; and others). Finally, a body of literature exists covering methods that have been tried to change students' attitudes (Friend, 1985; Gilbert, 1989; Mason & Kahle, 1989; Story & Brown, 1979; and others). Very few studies have examined whether a relationship exists between students' attitudes toward science and their overall attitude toward school (Haladyna & Thomas, 1979; Jaus, 1977; Talton & Simpson, 1986). The results of

many of the attitude studies have been contradictory and therefore inconclusive.

This research project was concerned with the relationship between students' attitudes toward school and science. Therefore, the review of research relevant to this study will cover three general topics: (1) students' attitudes toward science; (2) students' attitudes toward school; (3) correlations between students' attitudes toward science and school. Because the body of literature on student attitudes toward science is so broad, this review will be further limited to those areas where parallels may be drawn between the two attitude areas. Specifically, these are studies concerned with differences due to gender, type of community, attitude comparisons among different grade levels (representatives of elementary, middle, and high schools), and attitudes and achievement.

Students' Attitudes Toward Science

Harty and Beall (1984) attempted to see whether differences in attitudes toward science existed between gifted and non-gifted fifth graders and between genders. Scores on the Iowa Tests of Basic Skills and the Cognitive Abilities Test were used to classify students as gifted or non-gifted. Their sample consisted of an intact class of gifted students consisting of 12 girls and 13 boys and a

group of 25 non-gifted fifth graders paralleling these in race, gender, and socio-economic background. Demographic information on the schools was not given. Attitudes toward science were measured using the Children's Attitudes toward Science Survey, a revised version of the Attitude Survey for Junior High School. While the parent instrument was said to have face validity, no mention of validity was made concerning the altered instrument. No reliability coefficients were given for the present sample.

Because of the small sample sizes, the scores for both the gifted and non-gifted groups were checked for normality using the Kolmogorov-Smirnov goodness of fit test. Total scores were found to be normal, but the item distributions for the groups were not. Accordingly, t-tests were used to analyze total score results and Mann-Whitney U-tests were used on the individual items.

On a scale from 20 (most negative) to 100 (most positive), the mean scores for the two groups were 65.8 (SD = 10.1) for the gifted students and 65.4 (SD = 10.9) for the non-gifted group. Although the gifted students had a slightly more positive attitude based on their mean scores, they were not significantly different ($p=.88$). Similarly, all males exhibited a more positive attitude than all females (boys' \bar{M} and SD were 67.2 and 10.2 while the girls' were 63.9 and 10.6), though the difference was

not significant ($p=.27$). Non-gifted students displayed a more positive attitude than gifted students on the item "usefulness of science when playing and at home" (non-gifted \bar{M} and SD were 2.4 and 1.3; gifted \bar{M} and SD were 3.2 and 1.2; $p<.02$). While no significant differences were found on items between the genders of the non-gifted group, significant gender differences did surface in the gifted group. Males noted less difficulty "reading about science" ($V=35$; $p<.01$), scored more positive on "spending more time doing science experiments" ($V=31$; $p<.01$), and had fewer difficulties "understanding science experiments or activities" ($V=22$; $p<.001$). Of interest, the item responded to most positively by all groups was "usefulness of things done in science class," while the item with the most negative rating was "doing what real scientists do in science class."

The authors rightfully concluded differences between gifted and non-gifted fifth graders' attitudes toward science remain inconclusive. Some problems they listed with this study were: small and non-random sample; possibility of scientifically gifted students being included in the non-gifted group; and that gifted fifth graders may have feelings associated with being labelled as "gifted" and being grouped with others who are "gifted." Something to consider is while the authors' judging mean scores of mid-sixties on a scale of 20 to 100

"positive" is technically correct, it is suspect since answering each of the 20 items as "undecided" would yield a score of 60.

Harty, Beall and Scharmann (1985) studied the relationship between fifth graders' achievement in science and their attitudes toward science, interest in science, reactive curiosity, and verbal, quantitative, and nonverbal scholastic aptitudes. The sample was 149 white female and 144 white male students. No additional background on sample selection was provided. Data were collected over a span of three weeks, occurring simultaneously with the schools' administration of standardized tests.

The Iowa Tests of Basic Skills-Science Supplement was used to measure achievement. This test was reported to have a split-half internal consistency reliability of .86 and have face and content validities. No reliability coefficients were reported for the study sample.

The instruments used to measure attitudes toward science and interest in science were rewrites (not specifically for this study) of other tests, altered to be at a suitable reading level for fifth graders. Internal consistency reliabilities for the Children's Attitudes toward Science Survey were reported in the form of alpha (.76) and split-half (.74) coefficients. Again no statement of validity was made concerning this survey. A

Test of Interests was reworded to yield the Children's Interest in Science Measure. Face and content validity were noted for the original instrument, but no mention was made of the validity of the rewrite. Internal consistency reliabilities were reported in the form of alpha (.87) and split-half (.80) coefficients.

Curiosity was measured using a portion of the Children's Reactive Curiosity Scale. While the complete instrument was reported to have face, content and concurrent validity (no supporting details were provided), no mention was made as to whether the section chosen had validity on its own. Alpha (.77) and split-half (.77) internal consistency reliabilities were reported for the study sample.

Cognitive Abilities Test: Multi-Level Form 3 was used to determine the verbal, quantitative and nonverbal aptitudes of the subjects. This instrument was reported to have construct, criterion and factor analytical validities. Reliability coefficients (based on equivalence of alternative forms) have been reported as .94, .92, and .93, respectively for the three areas tested. No reliabilities were reported for the study sample.

Multiple regression analysis showed that 47% of the variance in science achievement could be accounted for by the six independent variables tested. Of that percent,

44% of the variance could be attributed to scholastic aptitude. Analysis using Pearson-product moment correlation showed significant positive correlations existed between achievement and all six predictor variables. However, the correlation existing between science achievement and attitudes toward science was weak ($r = .11$; $p < .05$). The authors concluded that while scholastic aptitude may be a tool used to predict science achievement, the same was not true of attitude.

Vanek and Montean (1977) sought to determine whether the method used in teaching science to elementary students affected their attitudes toward the subject. Gender and grade level were considerations. Students from two third grade (54 students) and two fourth grade classes (56 students) from a rural school in upstate New York were randomly assigned to two treatment groups at each level. One group was taught using the Elementary Science Study (ESS) curricula, which is a student-directed approach; the other was taught using curricula based on Laidlaw Science Series texts, a teacher-directed approach emphasizing written rather than manipulative activities. Both approaches were inquiry oriented, although no reported classroom observations were conducted to confirm this.

The treatment was comprised of instructing two units. It encompassed 20 forty-minute class sessions over a span of 6-8 weeks. The two teachers for each grade alternated

treatments by units so as to control for teacher variability. In the multivariate analysis of covariance performed on the results, the three factors in the study were treatment, grade, and gender. The dependent variables measured were posttest scores on the Piagetian Classification Tasks, the Science Attitude Scale (SAS), and the Science Achievement Test of the Stanford Achievement Battery, Primary Level III. The covariates were pretest scores on the Piagetian tasks, the SAS, and IQ. Although no details were provided, it was noted that the developers of SAS had ascertained that the instrument had content validity and a Cronbach's alpha of .87 for reliability.

Using a significance level of .05, no effects of treatment, grade level, gender, or interactions were found. The scores on the three tests were then examined separately. On the Piagetian tasks, again no effects were found. No treatment effect was found on the SAS; however, significant grade level and gender effects were found. Third graders scores were significantly higher than fourth graders on 90% of the ten SAS subscales. The significant gender effect on the SAS was that girls were more able than boys to seek information and weigh evidence before rendering a judgment. Also significant were interaction effects of treatment by sex. Girls in the ESS group were more open-minded than those in the text group while the

males exhibited the opposite behaviors. On the Science Test Achievement, the only significant effects were caused by grade level, with the fourth graders outscoring the third graders, as would be expected on this norm-referenced test.

The authors concluded that teaching method or materials used did not appear to affect classification ability, science achievement, or students' attitudes toward science. They suggested longer-range studies (six months or more) be performed for additional information.

The purpose of the study by Kyle, Bonnstetter, and Gadsden (1986, 1988) was to compare the attitudes toward science of students who had completed one year of The Science Curriculum Improvement Study (SCIIS) (a process-oriented curriculum) with those in non-SCIIS classes, as well as the attitudes of the teachers who taught SCIIS with those who did not. Student responses were also checked for any gender differences. The study was performed in the Richardson Independent School District in Texas because it was slowly introducing SCIIS into its 35 elementary schools. During the study year (the first implementation year), six schools were using SCIIS.

The instruments used in this survey were Preferences and Understandings-Student Version, an adaptation of a National Assessment of Educational Progress (NAEP) questionnaire, and Preferences and Understandings-Teacher

Version, developed to parallel the Student Version. The original student survey was altered to make it readable for younger students (second and third graders). The student instrument was used to develop analogous items for the teacher version. Both of the instruments used in this survey were reported to have content validity.

The data for this study were collected seven months into the SCIIS program. The teacher questionnaire was distributed to all K-6 teachers working with SCIIS and a random sample of ten teachers at each grade level who were not. Response rate was exceptional, with 108 of the 117 questionnaires returned. It should be noted that intensive in-service training was provided for both the administrators and teachers both before and during their involvement with the SCIIS curriculum.

The student questionnaire was distributed to 20 classes, randomly selected from among the teacher sample, to represent two SCIIS and two non-SCIIS classes in grades 2-6. The resultant student sample consisted of 228 SCIIS students (54% male and 46% female) and 228 non-SCIIS students (52% male and 48% female). It is interesting to note the similarities in gender and student number between these randomly selected groups. It should also be noted that classes, not students, were randomly selected; therefore, the units of study for analysis should have been classes not individual students.

The questionnaires were broken into subsections. Alpha internal consistency reliability coefficients reported for the subscales of this study, for students and teachers, respectively, were as follows: perceptions of their science teachers, .43 and .65; perceptions of science classes and usefulness, .81 and .83; perceptions of what it would be like to be a scientist, .73 and .38; and selections of definitions of scientific terms, .45 and .17. About half of these coefficients were quite low and lead one to question the reliability of these subscales.

The answers to the questionnaires were analyzed using Chi-square item analysis. Only one response of the 40 items yielded a significant difference between SCIIS and non-SCIIS teachers: the latter group felt being a scientist would make them feel important more so than the former (49% vs. 42%, $p < .05$). Significant differences ($p < .05$) were found for 27 of the 40 items between responses of SCIIS and non-SCIIS students. SCIIS students had more positive perceptions of science as a subject ($p < .05$) and as a class ($p < .001$). In addition, science made the SCIIS students feel more successful ($p < .01$), less uncomfortable ($p < .001$), and more curious ($p < .001$) than their non-SCIIS counterparts. Sixty-two percent of the SCIIS students "wish they had more time for science in school" as compared with 32% of the non-SCIIS students (significant at the .001 level). Significant differences

were also found between the two groups on perceptions of their science teachers. It was not noted whether any of the sample classes had a specific science teacher (i.e. not a classroom teacher teaching a period of science along with the other courses). Since that is not a common practice in most districts, one must wonder whether the questions concerning perceptions of "science teacher" were indeed reflective of the teacher's science teaching or general teaching practices. Both student groups view being a scientist similarly, with the only significant difference being the SCIIS students view it as more "fun" (40% vs. 39%; $p < .05$). Although significant, this percent difference does not seem to be a practical difference. On the definition subscale, the SCIIS students scored significantly higher than the non-SCIIS students on half the items.

The student data were also analyzed for gender differences. Males in the non-SCIIS group were more likely to choose science as their first or second favorite subject ($p < .001$) while females were more likely to list science as their least favorite subject ($p < .008$). Further, the females were less likely to: think their teachers wanted them to ask questions ($p < .04$); feel successful ($p < .028$); and think science study is useful ($p < .016$). In contrast, the only gender differences in the SCIIS group was the preference for area of science: both

males and females had comparable feelings toward life science, but females preferred physical science over the male-preferred earth science ($p < .012$).

The authors concluded the data strongly suggest that students in inquiry-oriented, process-approach science classes have more positive attitudes toward science and scientists than those in text-oriented classes. They suggested that inservice and preservice preparation in an inquiry approach to science teaching could greatly help in changing students' attitudes toward science.

Kyle, Bonnstetter, Gadsden, Shymansky, McCloskey, and Fults (1986) continued this research for an additional year. During the second year of the SCIIS implementation in the Richardson Independent School District, an additional eight schools were added. The purposes of this study extension were to compare the attitudes of first year SCIIS students with their responses as non-SCIIS students and with other non-SCIIS students; determine whether the positive attitudes exhibited by the students after the first year with the program continued through their second year (eliminate a Hawthorne effect); and to compare the attitudes of teachers working with SCIIS with those who were not. In addition, teachers working the new curriculum were asked for their concerns about using the program. Learning modes, activity context and specific

teacher and student activities in SCIIS and non-SCIIS classes were also assessed in this phase of the research.

As with the first year of the study, questionnaires were distributed to all teachers. Again, the return rate was rather high (87.3%). The student sample consisted of 230 first year SCIIS students (51% male and 49% female), 226 second year SCIIS students (54% male and 46% female), and 219 non-SCIIS students (49% male and 51% female).

Results were presented as percentages. No statistical comparison information was provided. The comparison of the students in their first year of SCIIS with non-SCIIS students from this study parallel those of the prior analysis. Over 50% of the SCIIS students chose science as a favorite subject while 16.9% of their counterparts chose likewise. The latter mirrored the students' own change in attitude; prior to the program (i.e. the first year of the study) 20.6% rated science as a top subject. Of greater interest, this positive attitude seemed to remain stable over time. The percentage of those in their second year with the program choosing science as a top subject (44.8%) compares quite favorably to how they responded after one year with the program (43.4%). The results of the teacher survey also repeated the results from the first year of the research: perceptions of SCIIS and non-SCIIS teachers were nearly the same.

In regard to classroom behaviors, the researchers, using a system they developed to assess teacher and student behaviors in elementary science classes, coded and analyzed 68 classes. The teachers were randomly selected to represent two first-year SCIIS and non SCIIS teachers each from levels 1-6 and two second-year SCIIS teachers in grades 2-6; and were observed for two full class meetings. The students were also randomly selected and their behaviors were coded for ten minutes during each of the two class periods. The Scott coefficients for interrater reliability were .87 for teacher and .91 for student codings.

The results, again reported solely as percentages, indicated that first-year students in SCIIS classes spent 82% of their class time working with manipulatives, compared with 72% in second-year, and 32% in non-SCIIS classes. It was also found that non-SCIIS students spent most of their time in large groups (greater than six students) without manipulatives. The researchers also claimed that females were more active than males, spending a greater percentage of their total class time using manipulatives. No basis for this conclusion was provided. The data provided on teacher instructional mode were similar to those reported on students. SCIIS teachers worked with manipulatives about 50% of the time while non-SCIIS teachers used manipulatives 16% of the time.

The second year of the study added strength to the conclusions made previously. The process-approach curriculum enhanced students' attitudes toward science.

Perrodin (1966) attempted to ascertain the attitudes toward science of 554 fourth, sixth, and eighth grade students from three school systems in Georgia. The districts sampled represented a large metropolitan area, a medium-sized city (population 50,000), and a rural area. The researcher developed an instrument of 20 sentence fragments which the students were to complete with the first thought that entered their minds. It was not necessary for the students to answer all questions. No mention was made of validity or reliability. The student responses were coded and summarized with the aid of a doctoral student in science education. No mention was made of interrater reliability.

Of the 20 items on the survey instrument, the author reported six reflected attitudes. Since the purpose of the study was to examine attitudes, one must question what the other 14 measured. The student results were grouped and listed as percentages for gender and grade level.

For the statements "Science is..." and "The science I have studied so far in school...", the student responses were categorized as very positive, positive, neutral, negative, or very negative. No examples of responses in each of these classifications were provided for the

reader. Based on the percentages of pupils' categorized answers, the author concluded attitudes were most positive in the fourth grade, less positive in the sixth, and least positive in the eighth.

A large number of responses to "When it is time for science class....," not surprisingly, were concerned with what the students do in preparation for the course (64% for fourth and sixth graders and 37% for eighth graders). Of the fragments that were categorized as attitudinal, fourth and sixth graders were more positive than negative (approximately 14% of fourth graders were positive and about 7% were negative while roughly 21% of sixth graders were positive compared with 5% responding negatively). Eighth graders, similar to the other two questions, had a more negative response rating (approximately 18% were positive while 28% were negative).

"The study of science is more important than..." and "less important than" fragments yielded responses showing students at all grade levels considered science to be an important subject. The most common response of fourth and sixth graders to "We study science because..." was "to learn more" (40 - 62%). Eighth graders were more likely to respond with "it's a requirement" (31%), followed by "to learn more" (26%) and "it's important" (24%). The author concluded, as other studies have suggested, that

favorable attitudes toward science decline as students progress through school.

Ayers and Price (1975) measured the attitudes of 455 fourth through eighth graders enrolled in five elementary schools of the Clay County Tennessee School System. This system is located in Southern Appalachia; therefore, most of the students came from low socio-economic families. The instrument Ayers and Price used was a combination of selected questions from two previously published questionnaires: one objective measure of elementary school students' attitudes towards instructional television and the other Perrodin's projective-type instrument discussed previously. No information on reliability or validity of the resultant instrument was provided. The classes were self-contained. Science was taught relying heavily on texts with rare opportunities for hands-on work.

Unfortunately in the reporting of the results, the authors provided no tables or statistical information other than selected percentages. They also reported only the results that they found to be of interest or importance. Even then, when giving percentages for responses, only those of certain grades were presented.

The data reported from the objective portion of the attitude inventory indicated that most students liked to study science (no figures given); over 66% felt school

science will be helpful after high school graduation; 55% felt that studying science in school is important; and most of the students liked the way they were being taught science (again, no percentages were presented). In general, the authors found that no major differences were found between science attitudes of males and females. Based on the percentage of students that answered positively to question items, it appeared that the attitude toward science of fourth graders was most positive and that of eighth graders least positive. The authors noted that attitude declined progressively from fourth to sixth grade, rose in seventh, and declined again in eighth. This drop between the sixth and seventh grades was noted but no possible explanations hypothesized.

Friend (1985) looked at science attitudes of seventh graders. He wanted to determine whether integrating science and mathematics would affect a student's attitude toward science and a student's achievement in science. His sample was four seventh grade classes in New York City, totalling 108 students from a middle-class background. Based on standardized reading and mathematics scores, two of the classes were at least two years above grade level while two were on grade level. One of each of these two ability groupings was taught with an integrated approach, while the remaining two classes acted as the control.

The author chose the seventh grade physics unit for the basis of his treatment. He examined each of the three sections comprising the ten-week unit (electricity, magnetism, and heat) and compiled a list of the mathematical concepts and operations needed for each area. The author and two other teachers were involved in instruction. The investigator taught science while the other two teachers (possessing similar professional backgrounds) taught the math classes. Each math teacher had one experimental and one control class. All teachers were familiarized with the physics curriculum and the list of needed math concepts and operations. The treatment group was taught the necessary math skills before they were required for use in the science class; in addition, math problems relevant to the science concepts were used as examples in these math classes.

The instrument used in this study to measure attitude was the Science Attitudes Appraisal. Content validity was reportedly determined by a panel of five science educators, including science department chairpersons and university professors. This inventory was administered before and then again after the unit. The Coefficient Alpha was given as .87. It was not clear whether this coefficient was for the pre or posttest. Achievement was determined using a teacher made Test of Physics Facts and Principles. This was used only as a post-test. It

consisted of 50 objective items. The validity was established by a panel of five science educators, this time composed of a science chair and four science teachers, each having at least 15 years of teaching experience. It had a KR-21 of .85, very impressive for a teacher-made exam.

The pre and post-treatment scores of The Science Attitudes Appraisal were compared using correlated t-tests. No change in attitudes was noted for either the above average or average ability students in either the experimental or control groups. An ANOVA for the achievement test scores showed a significant difference between the treatment and control groups of students above grade level ($p < .01$) but no difference between the groups of on grade level students.

Friend concluded that while these results did not support the thought that students will have better attitudes toward science if they have the needed math background, he did note that the above-level students started with highly positive attitudes (223.33 of 300.00), which did not leave much latitude for improvement. In contrast, the average students had lower initial scores. Unfortunately, the author ignored the question of why the above-average students started out with a more positive attitude than the average students in his study.

Finson and Enochs (1987) examined student attitudes toward Science-Technology-Society (STS), specifically whether these attitudes are affected by visiting an STS museum. The questions they sought to answer were: are there attitudinal differences between students who visit the museum and those who do not; are there differences in attitudes between students whose teachers prepare for the visit and those who do not; does prior classroom STS experience affect attitudes. They also examined differences between attitudes toward STS and socioeconomic status (SES), gender, grade level, school type (public versus parochial), and teacher characteristics.

The sample was intact classes of sixth, seventh, and eighth graders (totalling 194 students and 13 teachers) from several schools in Kansas. Schools were chosen so treatment (museum-visiting) schools' characteristics mirrored those of the control schools. No mention was made as to the number of classes in each group or whether this was a field trip usually taken by the teachers in the treatment group. The treatment schools visited the Kansas Cosmosphere and Discovery Center (KCDC), an award winning space-technology museum. Teacher instructional strategies for the field trip were grouped into three categories: structured, meaning pre-visit, in-visit, and post-visit activities were used; quasi-structured, in which two of these three activities were used; and unstructured,

wherein none of these activities was utilized. The control groups agreed to cover space science and/or STS topics in their classrooms.

The attitude instrument used in this study was the Scientific Attitude Inventory (SAI). These authors noted the questions of validity raised by Munby (1983a). Because no STS specific attitude instruments were available and SAI subscales 4A, 4B, 5A and 5B dealt with STS-type concerns, the authors assessed these particular sections for validity and reliability. They decided these items had content validity (no explanation of how they arrived at this decision was given) and a KR-21 coefficient of .82. The SAI was administered as a pre-test to all groups and then again as a post-test one week following the visitation to the museum. It was unclear why the entire inventory was administered when only those four previously mentioned subscales were used in the analysis. Also, since the entire test was given, reliability for the entire test needed to be established.

In addition to the SAI, student and teacher STS questionnaires were developed by the researchers. Rather than being attitudinal, their use was in determining the amount of STS the students had been exposed to in the classroom. Students receiving STS instruction for more than two class periods were considered to have STS

experience. The authors indicated the student version's content validity was established by submitting the instrument to 13 students in sixth, seventh, and eighth grades as a pilot. Likewise, the teacher version was field tested with 11 sixth, seventh, and eighth grade teachers. How pilot tests determine content validity was unclear. Kendall's Coefficient of Concordance was .66 for the student questionnaire and .78 for the teacher version.

Data were analyzed using analysis of covariance (ANCOVA), with the pretest scores as the covariates. Pearson Product-Moment Correlations were used on the teacher demographic data. It should be noted that the wrong unit of analysis was used. The number of classes, not the individual students, would have been the proper unit. Attitudes of visiting students were significantly higher than those of the control group (no level given). Significant differences ($p < .001$) were found among instructional methodology variables. Those receiving some structure from their teachers attained significantly higher scores than those with unstructured methodology. No difference was found between quasi-structured and structured strategies. The authors concluded that "sound pedagogy" applies to all educational experiences.

Attitudes were not significantly affected ($p > .05$) by the amount of STS learning that had occurred in the

classroom, nor by SES. Gender and school type also had no significant effect. Grade level differences were significant ($p < .05$), with the sixth graders being more positive than the seventh and eighth graders and the eighth graders being more positive than the seventh graders. The actual means for these grades were 35.48, 32.41, and 33.64, for sixth, seventh, and eighth grades, respectively. However, since no indication was given as to what the total possible score could be, it was impossible to ascertain the practicality of the differences found between these mean scores. It was suggested this dip in attitude may be due to the increased departmentalization of science classes, increase in lecture versus laboratory activities, and the stress experienced when moving from sixth grade to upper grades. The latter, in particular, was offered to explain why seventh graders were less positive than eighth graders. Finally, no significant correlations were found between teacher demographics and the STS scores ($-.19$ to $-.04$).

A study by Brunkhorst (1988) examined the effect of teachers on students' attitudes. The results of this survey did not show the usual trend of deteriorating science attitudes of middle schoolers. In a paper presented for the 1988 Annual Meeting of the National Association for Research in Science Teaching, Brunkhorst described the characteristics of ten exemplary

middle/junior high school science teachers (identified in the NSF/NSTA Search for Excellence in Science Education project) and compared the characteristics of their students with those of the general student population.

She reported that the exemplary teachers were highly experienced (averaging 18.5 years teaching), enthusiastic about the subject matter, read and used professional journals, presented at professional meetings (91% at national meetings), saw other teachers as resources, and used a variety of teaching strategies. These 10 teachers "selected" a class to participate in this study. No further information on the selection process was included. The sample size of these students was 280.

Each of the selected pupils completed four instruments: the Iowa Tests of Basic Skills Science Supplement, Levels 13 and 14; the Preferences and Understandings instrument; and the Science and Society instrument. The latter two devices were noted to contain affective items from the National Assessment of Educational Progress survey used to assess the general student populations in 1982 through 1984. No validities or reliabilities were given. The 1984 Study of Members of the National Science Teachers Association (N=750) was used as the informational source for the general student population.

When comparing achievement levels of students in the classes with exemplary teachers (hereafter exemplars) with those in the general junior high/middle school student population, the percentile rank for the exemplars was 87% while the ranking for the national norm was 50%.

Concerning attitude, the exemplars developed stronger positive attitudes toward science than their counterparts. Eighty three percent felt science class was interesting, 75% thought it was fun, and 59% found it exciting while only 15% thought class was boring. In comparison, 51% of the students in the general population found science class interesting, 40% found it to be fun, and 43% thought it was exciting while 29% found science class boring.

It was concluded that being taught by an exemplar made the students able to achieve more in the content area and nurtured positive attitudes in them. It was refreshing to see that "the onset of adolescence does not automatically lead to negative attitudes toward science." Research on what these exemplars did to positively affect the attitudes of their students or stall the onset of negative attitudes in them should be examined.

Several researchers worked on a longitudinal, multidimensional study designed to study the attitudes and achievement of a large group of science students from grades six through ten. The researchers hoped to examine as many home, school and individual factors as possible

that might affect student attitudes toward and achievement in science, and eventually develop a model which would synthesize their findings.

The sample for the study was selected from a large school system in central North Carolina and represented agricultural, industrial, upper middle class suburban, and military base areas of the district. The sample was drawn from students in the elementary, middle, and high school classes. In all, approximately 4,500 students and 78 teachers took part in the study.

Simpson and Troost (1982) developed the attitude instrument to be used in the study. It was a Likert-type questionnaire with 14 subscales. Each item was examined by a panel of two sociologists and three science educators for content validity. It should be noted that since the subscales were analyzed independently of each other, validity should have been established for each section, not the instrument as a whole.

To test achievement, criterion referenced tests for seventh, eighth, and ninth grade science were constructed and validated by six staff members of the school system. The tests were based on the local curriculum objectives. It seems unusual for the same people to both write and determine the validity of an instrument. In addition, semester science grades were also used as achievement measures. How these grades were determined by the

teachers was not explained. The achievement and attitude instruments were administered at the beginning, middle, and end of the 1980-81 school year.

As part of this investigation, Cannon and Simpson (1985) examined the relationships among attitude, motivation, and achievement of ability grouped seventh grade life science students. Their sample consisted of 821 students and 11 teachers. The students were placed into a basic, general or advanced ability group based on their 6th grade scores on the California Achievement Test and teacher and principal recommendations. This was a common practice of the school system and was not done for the benefit of this study. For these students, many of whom had no science instruction, life science was their first compulsory science class.

The subscales used in this study were the science attitude subscale and the achievement motivation subscale. Both had high KR-20s reported for them: .95 and .72, respectively; however, it is unclear why or how KR-20s were performed on a Likert-scale instrument. The KR-20 for the life science achievement test was found to be .91, a very high reliability coefficient for a teacher-made test. Data analysis was done using the BMDP program; Newman-Keuls Multiple Comparison Technique was used for post hoc comparisons.

Attitude toward science became significantly ($p < .05$) more negative as the year progressed for all ability groups and both genders. Student achievement motivation followed the same pattern as science attitude, with a higher starting than ending level.

Pearson Product-Moment Correlation Coefficients were calculated for the relationship between science attitude and achievement motivation. Coefficients of at least .60 were found to exist for all groups from the middle to the end of the year except for males in the basic ability group.

As predictors of achievement, scores on the achievement motivation subscale were ineffective but science attitude (regardless of ability grouping) at the middle (.054) and end (.0001) of the school year were significant. The researchers suggested that since attitudes may be related to achievement, variables associated with attitude declines need to be identified.

Simpson and Oliver (1985) examined attitudes toward science and achievement motivation of 3,663 students in grades 6-10. They used the data from the appropriate two subscales. Reliability coefficients were not presented. Results of the subscales were analyzed using ANOVA and Duncan's Multiple Range test (significance level set at .05).

Time, grade, gender, race, class, and school were significant main effects for both attitude and achievement motivation ($p < .0001$). In addition, interactions of school and grade, race and sex, grade and race were significant at the .05 level. The triple interaction of school, grade and time was highly significant for attitude ($p < .0001$). No actual means and standard deviations were reported.

Looking at a combination of grade level and gender with attitude, significant differences were not found between grades six and seven. These two levels also produced the most positive attitudes. In keeping with other reports, attitudes in grades eight and ten were the least positive, and were statistically different from the other grades. Unexpectedly, in this sample, attitudes in ninth graders were second highest. The authors postulated this may have resulted because only the "more advanced" students take ninth grade science. The data indicated a significant downward trend in attitude from the beginning to the end of the year, and from sixth grade to tenth grade (with the exception of the ninth grade, as mentioned above). Examining just gender and attitude, males possessed significantly more positive attitudes toward science than females at every level except ninth grade. The interaction of grade and race with attitude showed white students had significantly more positive attitudes than blacks in grades six through eight. In the ninth

grade this trend was reversed. By the tenth grade, no differences between races were found.

These authors did make an intuitive point based on the deteriorating attitude toward science supported by this research. They stated "...if most individuals turn away from science by the end of high school, is it not predictable that parents, political leaders, and even elementary school teachers will not value science as a basic subject of study and activity in our society" (p. 523).

A review of the literature by the authors indicated that self-concept, home environment, and school environment variables were important in determining student attitudes toward science. Thus, Talton and Simpson (1986) set out to examine the effect of each of these three categories (self, family, and classroom environment) on attitude and to determine which show the strongest relationship with attitude.

A number of subscales was used to collect the necessary data. For student perception of self, the following subscales (with their corresponding Cronbach's alpha) were used: achievement motivation (.90), anxiety (.52), science self-concept (.53), and self-concept (.50). The subscales for student attitudes about the family were family science (.65) and family general (.33). Seven subscales were used to measure attitudes toward classroom

and school environment: emotional climate (.53), science curriculum (.73), physical environment (.49), science teacher (.44), other students in the science classroom (.32), friends' attitudes toward science (.71), and attitude toward school (.42). The attitude toward science subscale had a reported alpha of .91. It should be noted that most of these coefficients were quite low.

Data were analyzed via multiple linear regression, using a significance level of .05, and R squared values were used to examine the amount of variance accounted for by the significant predictors. A regression model using all three categories of variables explained 60-82% of the variance in attitudes toward science. Separating the three categories, the results indicated that self variables accounted for 38-55% of the variance, family variables predicted 13-39% of the variance, and classroom environment variables were responsible for 46-73% of the variance. Hence, the category with the strongest relationship with attitude was classroom environment.

The researchers also looked at the individual subscales of these categories. In the self area, general self-concept was an occasional predictor of attitudes while achievement motivation, anxiety, and science self-concept were usually significant as predictors. It is important to note that attitude toward science was more strongly related to one's self-concept in the subject than

to one's general self-concept. Of the two family variables, family general was rarely a significant predictor but family science was always significantly correlated with attitude. Of the seven classroom/school subscales, climate, curriculum, and friends were almost always significant predictors of attitudes toward science. These conclusions were based on the number of significant predictors in each category for the three testing times in the five grades. Individual "r" values for each group of variables were not given.

A reduced model containing the most consistent significant predictors was regressed on attitudes toward science. The model of climate, curriculum, friends, science self-concept, and family science accounted for 56-80% of the variance in attitude toward science. Considering the full model accounted for 60-81% of the total variance, the reduced model appears to include the most important variables in determining the relationship between self, family and classroom environment with attitude toward science.

These data suggested educators can strongly affect student attitudes by manipulating the classroom environment. It was also noted that the home environment cannot be ignored in the attempt to instill in students positive attitudes toward science.

Talton and Simpson (1987) focused on 1,560 tenth grade biology students, and examined the relationship between classroom environment and attitude toward and achievement in science. The subscales used and Cronbach's alphas for each were: emotional climate of the science classroom (.50), science curriculum (.71), physical environment of the science classroom (.44), science teacher (.52), other students in the science classroom (.50), friends' attitudes toward science (.63), and attitudes toward science (.88). Most of these coefficients were low. The first six of these subscales comprised what the authors collectively referred to as the "classroom environment variables." The mean of the students' scores for each subdivision was used as the basis for analysis. Reliabilities for the teacher-made tests were not measured. The collected data were analyzed using Pearson product-moment correlations and multiple linear regressions. Because most of the reliability coefficients for the classroom environment subscales were low, corrections for attenuation were calculated.

The authors found that all the classroom environment variables were significantly correlated with attitudes throughout the school year ($p < .0001$), with curriculum having the strongest correlation ($r = .63, .66$, and $.68$ for the beginning, middle, and end of the year, respectively; corrected $r = .80, .84$, and $.86$) and climate and friends

being moderately correlated (for climate, $r=.62$, $.65$, and $.63$ with corrections of $.93$, $.97$, and $.95$; r for friends $=.56$, $.62$, and $.61$ and corrected $r=.73$, $.80$, and $.79$). Collectively, these three factors outweighed teacher, physical environment and other students in their association with students' attitudes toward science. None of the classroom environment variables were strongly correlated with achievement in science (r 's ranged from $.06$ to $.31$ and corrected r 's from $.10$ to $.44$).

Using regression, predictive models for attitudes toward science were determined. Climate, curriculum, other students, and friends were significant in predicting attitudes at the beginning ($R=.56$) and middle ($R=.60$) of the school year. For the end of the year attitudes, physical environment needs to be added to the model ($R=.61$). No attempt was made by the authors to explain the need to include this factor.

Predictive models for achievement showed that at the middle of the school year, all classroom environment variables were significant. At the end of the year, climate should be removed from the predictive model. These models accounted for 14% and 5%, respectively, of the variance. The authors suggested that because achievement was measured using teacher assigned grades and not using standardized measures that predictions and

correlations were not as high as they might otherwise have been.

In summation, based on these results, it would appear that interactions between classroom environment and attitude were not strong predictors of science achievement. However, a relationship did seem to exist between environment and attitude. Thus, in order to improve students' attitudes toward science, researchers might be advised to focus their attention on the classroom environment.

For the longitudinal aspect of this project, Oliver and Simpson (1988) attempted to ascertain whether attitude toward science, achievement motivation, and science self concept could predict achievement in science. Information was gathered on 850 students; this subsample was selected by choosing every other student from an alphabetized listing of students in the graduating classes of 1983 and 1985 (students participating in the original data collection while in the 8th and 10th grades). Data were collected by searching student records and noting the type and number of science courses taken, science grades, standardized test scores, and "other related information." Because the authors felt attitude toward science, science self concept, and achievement motivation in science influenced achievement, these three subscales were used. The Cronbach's alpha reliability coefficients for these

divisions were .90 for attitude, .85 for achievement motivation, and .55 for science self-concept.

A regression analysis of the three attitude subscales to science achievement yielded that all were significant predictors (significance levels ranged from .0001 to .02) with the exception of achievement motivation ($p < .22$) and attitude toward science ($p < .08$) in the 1985 graduating class. The authors reported that attitude toward science, achievement motivation, and science self-concept accounted for nearly 20% of the variance in achievement in chemistry of 11th graders and over 30% of 12th graders. The researchers acknowledged that these were rather high when compared with other published reports correlating attitude and achievement. In general, however, these values would not be considered high correlations.

Although the multiple regression data were not presented in the paper, the authors concluded that even though attitude toward science could not be used to predict achievement, it could be used to predict achievement motivation and science self concept.

Schibeci and Riley (1986) sought to identify variables which affect attitudes and achievement in science and to determine if attitudes affect achievement and vice versa. They drew two random samples from the 1976-77 National Assessment of Educational Progress (NAEP) Survey Booklet 4 data set, limiting themselves to the

surveys completed by 17 year olds. The first sample consisted of 350 students; the second, 323. The computer program LISREL IV was used to develop and test possible causal models. Cross-validation techniques, using a subsample of the original population, were used to establish the validity of causal model(s). Comparisons were also made among the possible models to increase the validity of the "chosen" model.

Using the analyses performed by Napier and Riley (1985), the variables used in the model were teacher support, teacher enthusiasm, usefulness, motivation, enjoyment, self-confidence, sex, race, home environment, material possessions, time spent on homework, parental education, amount of television watched, and number of schools attended. These variables were selected because of their correlations with the achievement scale on the NAEP survey. The final model generated by the LISREL IV (Chi-square = 87.95 ($p < .02$) for the first sample and 64.02 ($p < .21$) for the second) indicated a strong causal chain as follows: perception of science instruction----> attitudes---->achievement. The model reversing the positions of achievement and attitudes yielded a chi-square value of 220.33 ($p < .0$), indicating a poor fit. It was interesting that the p values listed do not appear congruent with the authors' interpretations. The authors

concluded attitudes affected achievement but achievement did not affect attitudes.

It was also found that of the variables noted earlier, the material background of the students, the amount of television watched, and the number of schools attended did not have enough of an influence to be included in the model; only variables with a ratio of parameter estimate to standard error greater than 2.0 were retained. All other variables remained in the model. Some particular relationships emerged. Gender was important, with females scoring lower on both the attitude and achievement questions in the survey. Race was influential on achievement: whites had the highest scores.

In summation, attitude affected achievement. Achievement was also affected by gender, race, home environment, and the amount of education one's parents had. Based on these data, the authors concluded that what science teachers do in the classroom affects student attitude and achievement.

Levin and Fowler (1984) examined differences of students' attitudes toward science based on sex, grade level, and science programs. Their sample was the students in an large (population of 1,700) urban senior high school in Pennsylvania. These students were in

grades 10 through 12 and were mainly white and from lower to middle socioeconomic groups.

The Science Attitude Packet, constructed by the authors, had eight subscales measuring: usefulness of science, science self-confidence, perceptions of science as a male domain, perceptions of mother/father attitudes toward the student's ability in science, perceptions of teacher attitudes toward the student's science ability, effects of success in study of science, and how much the student liked science. The test consisted of 12 items for each subscale, randomly ordered in the final five-response Likert format. The content validity was determined by staff members at the Pennsylvania Department of Education. No other form of validity was reported for the instrument. Nine hundred eighty eight completed surveys were used in the analysis. Reliability coefficients were determined for each subscale; they ranged from .83 to .92.

The researchers found the females had significantly more positive attitudes than males ($p < .01$) on three of the subscales: consequences of success (female and male means of 46.2 and 44.06, respectively), science as a male domain (52.33 and 44.0), and teacher's perceptions of their ability (41.28 and 40.03). Significant ($p < .05$) grade differences were found on all subscales except the motivation scale. Tenth graders were significantly less positive than eleventh graders on all the subscales

($p < .01$), except motivation. Significant mean differences ranged from 0.29 to 2.46. No significant differences were found between eleventh and twelfth graders.

The students were placed into one of four science program categories for analysis: advanced placement, academic (college preparatory), general, and terminal (only one year of science). Significant differences ($p < .05$) were found among the categories. In general, attitudes became less positive from the advanced placement to academic to general to terminal categories.

Yager and Bonnstetter (1984) used the 1977 NAEP survey data as well as some follow-up data they collected in 1982 to determine whether any changes in student perceptions of science teachers, classes, and course content had occurred during that five-year interval. The instrument they used in 1982 was portions of the NAEP survey. The validity and reliability of this instrument were not noted. The sample was 700 randomly chosen 9, 13, and 17 year-olds and young adults.

In comparing the two data sets, the authors found no difference between the perceptions over the five-year period. Generalizing the findings, science was viewed as most exciting, fun, and interesting by the younger students; with this perception progressively decreasing with an increase in age.

Yager and Yager (1985) extended the above study. Using the same instrument as Yager and Bonnstetter (1984), they sampled approximately 150 students in each of the three age groups (9, 13, 17) by randomly selecting homerooms in the Cedar Rapids School District. They compared these new data with the data collected from the 1977 NAEP survey, 1982 NAEP survey, and 1982 Iowa follow-up study. Again, the data from this new study mirrored what was concluded from the other surveys.

The perception of science class as fun, interesting, and exciting was highest in the lower grades and decreased as one progressed through the higher age groups. Science classes were seen as increasingly boring across the groups and made the older students felt more uncomfortable and less successful. Science class was viewed as being useful by all students regardless of age.

In 1984, data were again collected using the 1977 NAEP survey affective items. Twenty-nine schools and 750 students were involved in this random sample. Yager and Penick (1986) took this 1984 data and compared it with the affective items from the 1977 and 1982 NAEP data reported on previously. As with the other studies using the NAEP data, no change was seen in the 1984 data compared with the earlier results. All responses over the seven year span remained rather constant.

Barrington and Hendricks (1988) performed their own study using the attitude instrument developed from the 1977 NAEP survey by Yager and Bonnstetter (1984), described previously. They sought to replicate findings of grade-level differences on perceived attitudes toward science and science concepts from grades 3 through 11, subject their data to more extensive statistical analyses than in previous work, and check for gender and intellectual ability differences. The sample consisted of 143 third, seventh, and eleventh graders from two medium-sized school districts in Wisconsin. Two ability groups, gifted and average, were determined using results on the Otis Test of Mental Ability; with the gifted students scoring IQs greater than 130 and the average receiving scores of between 95 and 105. The two ability groups and both genders were approximately equally represented in the sample. No mention was made of what happened to students falling in the middle of these two ranges on the test.

Besides the attitude instrument, a measure of content knowledge developed by Yager and Yager (1984) was administered. The latter instrument consisted of eight factual multiple choice items measuring knowledge of terms and concepts. No mention of validity for this test was made. Scores for the four attitude categories were analyzed separately and as a composite score. Analyses of

variance were used to determine the impact of grade level, ability group, and gender on attitudes.

The authors calculated reliability coefficients for each of the attitude scales, the composite score, and the content test. These were Cronbach's alpha, average inter-item correlation, and average item-scale correlation. The coefficients for the content test were all poor: .36, .07, and .16, respectively. The alpha coefficients for the attitude scales ranged from .51 to .80. The average inter-item correlations and average item-scale correlations were lower, ranging from .13 to .38 and from .25 to .53, respectively.

The results of this study differed from those of many of the previously reported works. The usual pattern of an increasingly negative attitude from third to eleventh grade was absent. Using the composite score, a significant decline was seen from grade three to grade seven ($p < .001$) but a significant increase was evident from grade seven to grade eleven ($p < .001$). The authors noted that since the eleventh grade sample came from two different school districts with very different science programs, the reason for the attitude improvement was apparently not related solely to the high school science program.

A comparison of the ability groups indicated the attitudes of the two ability groups paralleled each other

between third and seventh grades; then the gifted group's attitudes showed a more dramatic improvement than those of the average ability students. Although not significant, females appeared to have more positive attitudes than males.

James and Smith (1985) focused on the decline of attitudes from grade school through high school. They sought to determine the grade level at which subject preference and attitude toward science scores have the largest decline for Black students, female students, and all students. Their sample was 6,082 students in grades 4-12 from three suburban school districts in Kansas.

The instrument used in this study was composed of three sections. The first section consisted of pairwise comparisons of each subject with all subjects; that is, students chose their preferred subject from each given pair. Section II was comprised of 13 items from the 1977 NAEP survey. Section III was included to collect demographic information. No validity was reported for the instrument. Pearson correlation coefficient for test-retest reliability was calculated at a respectable 0.77.

Results were analyzed using ANOVA and the Scheffe Test. A two-way ANOVA analyzed the comparisons between gender and between Blacks and the rest of the population. The significance level for all tests was set at .05. It

should be noted that no racial breakdown of the sample was given, except that 689 of the respondents were Black.

When examining data for all grade levels, the largest decreases in positive attitudes toward science occurred between the sixth and seventh grades. Comparisons of Blacks with the general population showed that the greatest attitude change again occurred between the sixth and seventh grades. Females followed suit, with the greatest attitude change occurring between the same grade levels. Blacks preferred science more than females and the general population in grades 4-7, but appeared at or below the general population preference at the higher grades. Females consistently ranked science at or below the preference level indicated by both Blacks and the general population across all grades.

The authors suggested several reasons for the drop in attitude occurring between sixth and seventh grade. One was that seventh grade is generally when science is treated as an individual subject in a separate classroom. It is also the time when the course is required and graded. Seventh grade may be the first time students extensively use problem solving techniques.

The authors' reasoning may hold true for this particular group of students. Their graph of subject preference appears unlike what would be expected from other studies. Rather than showing a steady decline

through the high school years, their graph indicated a steady increase in the general population from 7-12 grades. Why this group did not show the more typical pattern of a steady decline would be interesting to investigate.

Summary

In general the studies concerning students' attitudes toward science indicated that students in upper grades felt less positive about science than students in lower grades. Only the studies by James and Smith (1985), Barrington and Hendricks (1988), and Brunkhorst (1988) did not show a progressive decline. If gender differences were seen, usually the male possessed the more positive attitude. School type did not seem to be related to attitude. The data from the studies of Friend (1985) and Barrington and Hendricks (1988) indicated that students of higher science ability seemed to have more positive attitudes toward science. However, most studies found that attitude was either not related to or weakly correlated with achievement.

The reader is reminded that the results of some of these studies may not be trustworthy. As noted in the individual research reviews, many of the instruments used were not shown to have reliability and/or validity. In addition, other methodological flaws were sometimes

present (i.e. no interrater reliability reported, validity determined for the whole when subscales were used, use of the incorrect unit of analyses, etc.). It should also be noted that most of these studies were conducted with small, all white samples in specific geographic areas; the findings should not be generalized to more than the subject population.

Students' Attitudes Toward School

Darom and Rich (1988) compared teachers' perceptions of students' attitudes toward school with the students' self-reports. The sample was 53 Israeli school classes, comprising grades 4-12. Although different grade levels were surveyed, the emphasis of the study was on gender differences rather than amount of school experience.

The authors devised their own instrument, the Israeli Quality of School Life (IQSL). The specific attitudes measured were general satisfaction with school, commitment to schoolwork, and relations with teachers. Alpha reliabilities for each scale were acceptable (.68 to .71). Validity of the instrument was not reported. Teachers were given surveys to fill out for each of their students. These were compared with the actual survey results of the corresponding students.

The results indicated that girls report more positive attitudes than boys, although the difference was not

great. Interestingly, teachers viewed girls as being substantially more positive toward school than boys. Using multiple regression analyses, the authors explored whether gender of students affected teacher perceptions differently depending on the grade level. The authors grouped the sample into grades 4-6, 7-9, and 10-12 because previous research by the authors indicated that there is a general decline in students' attitudes with increasing grade level. The authors found that student gender influenced a teacher's perception of students' attitudes most greatly in the lower grades (4-6), and had a decreasing influence until the high school level where student gender could not be used as a predictor of teacher perception. The authors did note that compulsory education in Israel ends at grade 10. They suggested that gender was not a factor in teacher perception of students' attitudes toward high school since these students comprise a select group.

It is unfortunate that the authors did not present the student attitude data by grade level or present raw data instead of just correlation coefficients between student self-reports and teacher perceptions. Accordingly, no conclusion can be made concerning whether students with more educational experience were less positive about school.

Berk, Rose, and Stewart (1970) were concerned with comparing English and American students' attitudes toward school. They were particularly interested in the relationship between attitude and socioeconomic status, ability, and gender. They replicated a study that had been done with British children, using American students as the sample. The comparisons were done using the results of the British study and the results of this study.

The sample was 565 fourth and fifth grade students from a variety of socioeconomic backgrounds. The instrument used had a three-point response scale and was comprised of 62 statements. No mention of validity or reliability was made. Information on the students' academic performance and socioeconomic status was obtained from the teachers.

Data were analyzed using an ANCOVA and a partial regression analysis. The authors found that American children were more positive than British children. They also found that unlike students in England, no relationship existed between attitude and either socioeconomic status or ability. The data did indicate that American girls were more positive toward school than boys. The authors suggested that since girls tend to be less critical than boys, one must question whether females

tend to like school more or just appear to because of their nature.

A study by Jackson and Getzels (1959) found results similar to those above. These authors examined the relationship between student satisfaction with school and gender and ability. The sample was chosen using the results of the Student Opinion Poll (no validity or reliability was mentioned) which was administered to 531 students, comprising seventh through twelfth graders from a private Midwestern school. Students scoring at least one and one-half deviations above the group mean on the survey were classified as satisfied and those scoring in the opposite direction from the mean were considered dissatisfied. These two groups, then, formed the sample for the study. Forty-seven students were in the dissatisfied group and 45 made up the satisfied group.

These students were subjected to a battery of tests (no validity or reliability was noted), which included achievement tests, a personality test, sentence completion tests, and psychological tests (eg. Rorschach). Teacher ratings concerning ability, leadership qualities, and "general desirability as a student" were gathered for each student.

The results indicated that student satisfaction level with school was not affected by ability or achievement. Rather, differences could be seen based on psychological

variables. The authors noted that teachers perceived males differently than females. Similar to the analysis by Berek, et al. (1970), these authors suggested that since boys and girls express their dissatisfaction in different ways, teachers may not be able to discern students' attitudes based on gender. Similarly, the data showed that dissatisfied boys tended to be more negative than dissatisfied girls. Interestingly, the authors also noted that even the most satisfied students used some negative adjectives in describing their feelings toward school. Since the authors presented their data solely on the basis of gender, no grade level differences could be discerned.

Glick (1970) was interested in determining the extent to which friendships affected students' attitudes toward school. He examined 14 sixth grade classes (350 students), representing both middle and upper-middle class white communities, in a Midwestern metropolitan school system.

Two instruments were administered to the students, both at the beginning and the end of the school year. One was entitled "Naming Your Friends," which directed the students to write the first and last names of their five best-friends (not necessarily from the school). The other was a 60-item Likert-type attitude instrument comprising four scales: attitudes toward teachers, school work,

classmates, and school in general. Only the overall score was used in the data analysis. No mention of reliability or validity was made. Data were analyzed using ANOVA and correlations.

The author found that students' attitudes toward school were not affected by whether students have friends in the school. However, the more popular a student was in school, the more favorable the student's attitude appeared to be. In general, friends tended to have similar attitudes toward school.

The findings concerning gender and SES background led to several patterns. Low SES females had the least favorable attitudes toward school while high SES females had the most positive. These feelings intensified over the course of the school year. In high SES classes, male attitudes decreased over time while female attitudes increased. In the low SES classes, the opposite was true. In general, the authors felt that girls tended to be more positive in their attitudes toward school than boys.

Jackson and Lahaderne (1967) explored how accurate teachers' perceptions of students' attitudes toward school were and also the relationship between achievement and attitudes. They also examined gender differences. The sample was comprised of 148 boys and 144 girls from sixth grade classes in a white, working class suburb. Eleven teachers were associated with these classes.

Two attitude instruments were administered to the students at the end of the school term: the Student Opinion Poll II and the Michigan Student Questionnaire. While validities were not noted, KR-20 was .86 for the former survey and .95 for the latter. The correlation between the results of the two surveys was .62, which the authors felt was low enough to justify their use of both instruments in gathering data.

Teachers were presented with sample questions from the Student Opinion Poll II so they would know on what basis the students' attitudes were being ascertained. The teachers were then asked to group their students into three levels of satisfaction (most, average, and least). These levels were subdivided to form a total of five categories ranging from most satisfied to most dissatisfied.

Achievement was measured using grades from the present teacher in reading, language arts, arithmetic, and science. Scores from the Stanford Achievement Test in reading, language arts, and arithmetic were also used.

The results indicated that the correlations between achievement in the various areas and attitude were small ($p < .2$). The only significant correlation was between the girls' attitudes as measured with the Student Opinion Poll II and science ($r = .19$, $p < .05$); and that correlation was also not impressive. In addition, the data showed that

teachers were better at describing achievement than attitude. Further, no significant gender differences were evident.

The authors suggested that teachers and parents affect the "natural connection" one would expect to find between achievement and attitude. They felt teachers and parents, by either assigning homework, setting deadlines, and/or checking the work, affect students' achievement. Thus, more than attitude is working on how well a student performs in school. This observation follows logically.

Berliner (1985) reported on a study Hedelin and Sjooberg presented at the first European Conference for Research of Learning and Instruction held in Belgium, 1985. These researchers sampled a "large" number of students in grades 1, 3, 5, 7, and 9 concerning their attitudes toward school. The results indicated that students in the upper grades liked school progressively less than students in the lower grades. Berliner said this trend is common in all the Western democracies. Unfortunately, no citations were given to support his comments.

Summary

The research on student attitudes toward school all shows basically the same patterns. Girls tend to be more positive toward school than boys. Questions have been

raised as to whether this gender difference is an actual difference or just a difference in how sexes portray their feelings: it is felt that girls tend to be less rebellious and are less likely to express negative feelings than boys.

The relationship between attitude toward school and achievement, when present, is weak. Teachers do not seem to have accurate perceptions of how students feel about school. Finally, one study indicated an interaction between socioeconomic status and gender.

While many of these studies sampled students from a variety of grade levels, none of them reported on differences or similarities between these grade levels with the exception of the reporting by Berliner (1985) and previous work done by Darom and Rich (1988). Glick's (1970) data did not show a consistent pattern of decline or increase in attitude over the course of a school year.

When viewing these results, it is important to remember the instrumentation problems noted with the studies. Of the six instruments used, none of them had reported validities. Only half of the surveys had reported reliabilities. Without the assurance of the validity and reliability of the instrumentation, one must use caution in accepting the findings.

Students' Attitudes Toward School and Science

Haladyna and Thomas (1979) examined the attitudes of elementary school children toward school and subject matters, and looked for trends based on grade level and gender. The sample was 2,845 first through eighth graders, chosen because their teachers were involved in a concurrent mathematics survey conducted by the authors.

The authors designed their own data collection instrument, the ME. This instrument consists of a series of five questions that are repeated for each subject area and for school. Only the key word in each statement is changed to match the attitude topic being measured. The answer scale is a series of three faces, showing a happy, neutral, and sad countenance. The instrument was said to have construct validity, based on principal components analysis and factor loadings. The alpha internal consistency estimates ranged from .61 to .89. It should be noted that the primary ME instrument measured attitudes for school, reading, math, physical education, art, and music; the intermediate version also measured attitudes for social studies and science. The tests were administered by the classroom teacher.

Means and standard deviations were calculated for each scale on the ME. The scale scores could range from 0 to 10. Due to the large sample size, the authors used a significance level of .01. Practical significance was

determined using one-third of a standard deviation between sample means as a criterion. For unspecified reasons, data from grades seven and eight were grouped together and reported as one figure. The authors found that mean attitude toward school declines steadily from grades one through seven and eight. With the exception of music, the attitudes toward the subject areas did not show this decreasing linear progression. The authors also noted that the mean ratings of attitudes toward all subject matters (means ranged from 5.38 to 8.10), except social studies (4.14), were above the mean rating of attitude toward school (4.69). The standard deviations in all cases were rather large, ranging from 2.4 to 3.2. It is important to note, however, that in seven of the eight scales, the largest decline is found in attitude between sixth grade and grades seven and eight. They concluded their findings showed a "large scale decline in attitudes toward virtually everything that happens in school" (p. 138). The scale that did not exhibit this drastic decline was music, which had a major decline between grades five and six.

Gender differences were evident. Concerning attitude toward school, although not of practical significance, females ($\bar{M} = 5.81$, $SD = 2.4$) were more positive than males ($\bar{M} = 5.34$, $SD = 2.6$) in grades 1-3. Girls in grades 4-8 were more positive toward school than boys ($\bar{M} = 4.42$, $SD =$

2.2 vs. $\bar{M} = 3.64$, $SD = 2.1$). Note that boys became increasingly more negative than girls as the grade level increased. Concerning attitudes toward science, boys in grades 4-8 were significantly more positive ($\bar{M} = 6.32$, $SD = 3.1$) than were girls ($\bar{M} = 5.58$, $SD = 3.1$).

In conclusion, the authors suggested (as have others) that the drastic dip in attitudes toward school from grades 6 to grades 7 and 8 may be caused by the change from a self-contained to a departmentalized school situation. They saw no parallel between declines in attitudes toward subject matter and the overall decline in school attitude, and felt attitude toward school could not be determined by examining only attitudes toward subject matter. They suggested future studies focus on the reasons for the decline in attitudes toward school.

Several reservations concerning the results of this study should be examined. Although the authors indicated their instrument had validity and reliability, one must question whether answering six and eight sets of identical questions is the best method for gaining information. The instrument also has some contextual problems. For example, one question asks, "What face do you wear when ____ is over?" A student's response to that question may be influenced as much by what class is next as by how the student actually feels about the subject. Also, one must question the use of faces with children in grades 4-8.

Jaus (1991, personal communication) has indicated that the use of "smily" faces with students in levels above third grade is not a good practice. He has found that older students are "offended" by this type of response questionnaire and consequently do not take the survey seriously. It would have been interesting to see the grade level reliabilities and the reliabilities for the individual scales, instead of reporting the averages. Additionally, the authors reported the lower reliability estimates were for the school and reading attitude scales because an item was defective. Since the same items were used in every scale, this suggested "defect" is another cause for wonder.

Another concern is the high standard deviations of the means. As an extreme case, the total mean for the social studies scale was 4.14. The standard deviation was 3.0! The standard deviations for the scales measuring attitude toward science and attitude toward school were each half as large as the total means (mean = 5.97, SD = 3.1, and mean = 4.69, SD = 2.4, respectively). With such a wide range, it seems difficult to make any strong statements concerning the survey results. One may also question why the authors make their generalizations based on the mean of the grade level means. Finally, the authors made no statement cautioning the reader that the "trends" occurring through the grades are not reflective

of particular students; that is, different students are being surveyed so the students in any particular grade level may not necessarily exhibit the same decline when they are promoted.

Jaus (1977) examined whether activity-oriented science instruction affects elementary students' attitudes toward science and school. His sample consisted of 154 second, third, and fourth graders from a low socioeconomic school. Two classes were examined at each grade level: in one science was "taught" by having students read texts and answer end-of-the-chapter questions; in the other, an activity-oriented approach was used. In each class, approximately two hours per week were allotted to science instruction.

Two different teachers participated at each grade level. One from each pair was randomly selected to receive ten hours of training in implementing hands-on science curricula in the classroom. The treatment and control groups were exposed to the same subject matter in their classes.

The author designed his own attitude instruments. Both surveys were comprised of ten questions, and the response scale was a series of five faces ranging from broadly smiling to deeply frowning. Scores could range from 10 to 50. The instruments were determined to have face validity by a panel of 12 professors of science

educators. Although reliability for the study sample was not provided, test-retest reliabilities for a group of 86 second, third, and fourth graders were .93 for the science attitude instrument and .76 for the school attitude instrument.

The instruments were administered prior to and again at the end of the 12-week study period. The gain scores were analyzed by t-tests. On the attitude toward science survey, the average gain score for the treatment group classes ranged from 10.0 to 13.0. In the control group, the fourth graders showed a decline (-0.7), while the other two grades had a slight increase (0.4 for second grade and 1.7 for third grade). Not surprisingly, the t-tests showed the gain scores for each of the treatment classes was significantly different but no significant gain in attitude was evident in the control groups ($p < .001$). It would have been more appropriate for the author to have used ANCOVA rather than t-tests in analyzing gain scores. The author also noted that the pre-test scores showed the typical decline in attitude toward science from lower to higher levels. In this study, means for the treatment group were 36.0, 33.0, and 30.1 for the second, third, and fourth grades, respectively. Control group means were 38.2, 30.6, and 27.0. No standard deviations were reported. Post-test means also showed a decline. Treatment groups averaged

46.0, 45.4, and 43.1, for grades two, three, and four, respectively. The control averages were 38.6, 32.3, and 26.3.

The results of the attitude toward school survey were similar to those reported above. The average gain score for second graders in the treatment group was statistically significant at the .01 level. The gain scores for the other two levels was significant at the .001 level. No significant difference was found among students at any level in the control groups. Again, when the means for each level are compared, student attitude toward school decreased at higher levels. The means on the pre-test for the treatment group were 41.0, 32.5, and 23.0 for grades two, three, and four, respectively. The control group means were 38.0, 33.0, and 24.0. The post-test means for the treatment groups were 45.0, 39.7, and 32.7. The corresponding values for the control group were 39.2, 32.5, and 25.1.

Jaus concluded that this study provided some evidence that activity-oriented science not only improves a student's attitude toward science but may affect a student's attitude toward school as well. He was careful to note that too many uncontrolled classroom variables existed to fully credit the change in science curriculum for the change in school attitude.

There are several drawbacks to this study. No mention was made of classroom observations to ensure that the science classes were being conducted in the prescribed manner. In addition, reliability of the instrument should have been calculated for the sample students, and more than face validity should have been determined. Of course, presentation of standard deviations would have aided in evaluating the data. The teachers may be a variable, although randomly assigning teachers to the control and treatment classes did help. Overall, however, this study appears to have been reasonably done.

As part of the multi-dimensional, longitudinal study (Cannon & Simpson, 1985; Simpson & Troost, 1982; and others) described in the section on Students' Attitudes toward Science, Talton and Simpson (1986) examined the relationship between attitude toward school and attitude toward science. The researchers administered a multi-scaled attitude questionnaire in grades 6-10, at the beginning, middle, and end of the school year. Attitude toward school was found to be a significant predictor of attitude toward science only for the beginning and end of the school year for eighth graders ($p < .05$). This finding led the authors to conclude that virtually no relationship exists between these two variables.

Before one can accept this finding, one must examine the data collection instrument upon which it is based.

The Cronbach's alpha for the six-item attitude toward school subscale was .42, which is rather low. A look at some of the questions indicated the attitude concept was poorly defined. For example, some items included: "The principal of this school is nice;" "Most teachers at this school are fair with the students;" "The harder I try, the better I do at school." Given the ambiguity of the attitude being measured and the poor reliability achieved by the scale, the finding of no relationship between school and science attitudes must be taken lightly.

Summary

Obviously, the three studies presented conflicting results. These studies are not directly comparable. Haladyna & Thomas (1979) studied a wider range of grade levels and subject areas than did Jaus (1977) and Talton & Simpson (1986). The instrumentation in the studies was also quite different. In examining the results of these studies, the concerns about the validity and/or reliability of the questionnaires must be considered. It is best to conclude from these reports that more data are needed before one can determine whether a relationship does in fact exist between students' attitudes toward school and science.

Review of Instrumentation

One of the main problems with attitude research is the lack of information on validity and reliability of the testing instruments. Another serious problem is the lack of a clear definition of what is being measured. Munby (1983b) suggested that the conflicting findings of much of the research on students' attitudes toward science may be due to the quality of the instruments being used. Judging from the instruments used in school attitude research, the same may hold true for that area as well. It is imperative in any new research on attitudes, then, that the instruments used be selected/constructed with care to ensure their reliability and validity. A review of existing measures in attitude toward science and attitude toward school was undertaken.

Review of Attitudes Toward Science Measures

The literature review was not fruitful in providing possible science attitude instruments for use in this research. Reliability problems aside, none of the 12 instruments reported on measured the attitudes of students toward science as a classroom subject. Therefore, all of them would be lacking content validity for this study.

The Tenth Mental Measurements Yearbook (Conoley and Kramer, 1989) and Test Critiques: Vol. VIII (Keyser & Sweetland, 1991) were consulted in an attempt to locate

attitude instruments. Neither listed any instrumentation which measured students' attitudes toward science, either as a subject or in general.

Munby (1983b) conducted a search of the literature on attitude measurement in science education from 1967 to 1977 and found there were over 200 instruments in existence. In his review, Munby analyzed 56 of these instruments. He found 21 had no reported reliabilities and 18 had no evidence of validity. Only four instruments did not contain cognitive items along with attitude items. Munby felt of the 56, seven instruments had merit, and even these were not perfect. In general, Munby suggested unnecessary duplication existed in the development of new instruments, felt the huge number of available instruments caused the science education community to be lax in scrutinizing attitude research, and called for an increase in communication among researchers.

An examination of the instruments critiqued by Munby (1983b) and a further search of the literature yielded only one possible instrument: The Test of Science Related Attitudes, developed by Fraser. A number of studies using this instrument and reviews concerning it showed it to be a valid, reliable measure of student attitudes toward science. Two problems existed with employing the instrument in this study: (1) of the seven subscales,

only one pertains to this study's definition of attitude toward science; and (2) the test is out of print.

Mayer (1974) compiled information on unpublished instruments useful for science education research. None of the measures reported in this ERIC document was appropriate for use in this study based on the definition of attitude toward science. The attitudes being measured by the instruments were either not clearly defined or encompassed scientific attitudes as well as attitude toward science

Personal communication with Shrigley (January, 1991) led to the discovery of an instrument he helped develop which was designed specifically to measure students' attitudes toward science as a classroom subject. The instrument was shown to be valid and reliable, and thus was chosen for implementation in this research. More specific information on this measure will be provided in the Instrumentation section in Chapter III.

Review of Attitudes Toward School Measures

As noted earlier, few references were found concerning instruments measuring students' attitudes toward school. Of the six instruments used in the literature reviewed, none of them had reported validities. Reliability coefficients were reported for only half of them. All instruments measured attitudes that were more

specific than those being examined in this study. None measured just students' attitudes toward school in general and the value of schooling, but also included questions from areas such as commitment to schoolwork, relations with teachers, effect of friends, classroom procedures, the curriculum, etc.

The Tenth Mental Measurements Yearbook and Test Critiques: Vol. VIII were referenced for help in locating alternate instruments. As with attitudes toward science, the Tenth Mental Measurements Yearbook (Conoley & Kramer, 1989) was not of use in this search. One school attitude measure was described in Test Critiques (Keyser & Sweetland, 1991), but, as with the others, of the five subscales only one was valid for this study.

Shaw and Wright (1967) compiled attitude measurements. Their book contained three attitude measures concerning school and/or the classroom. These scales, however, were dated and/or measured constructs not pertinent to this study. Some example statements are: "A high school graduate is often worse off morally than he was before going to high school," "High school teachers are parasites on the community."

A further review of the literature yielded two references to instruments that might have been of possible use in this study: "Student Survey and Attitude Inventory: Form A" and "Attitude Toward School."

However, no response was received from letters to the publisher of one and the authors of the other. Therefore, these two measures were not available for examination.

Personal communication was made with both Shrigley (January, 1991) and Oliver (February, 1991) concerning possible instruments to use in measuring students' attitudes toward school. Neither of these researchers knew of any measures that might be useful for this study.

Jaus and Haladyna were contacted and asked for copies of the instruments they used to measure attitude toward school. Haladyna's ME instrument was determined to be unacceptable for the purposes of this study. This school attitude instrument consisted of only five questions; these were directly linked to choosing faces, an inappropriate activity for the present sample. Jaus's instrument contained ten items and was geared to measure the construct of this study. It was found to be reliable; unfortunately, only face validity had been determined for the instrument.

Because no satisfactory instrument to measure students' attitude toward school was found, one had to be created for this research. This scale will be discussed in greater detail in the Instrumentation section of Chapter III.

Discussion and Conclusions

The body of literature concerning students' attitudes toward science and school paints an inconsistent picture. For instance, looking at the data from the attitude toward science studies, the effects of race, gender, ability, and year in school are undecided. Some studies found these variables to be significantly related to students' attitudes toward science while others did not show ethnicity, gender, achievement, or grade level to be of consequence. The findings of the school attitude studies are also unclear. Berliner (1985) and Darom and Rich (1988) reported on declining attitudes with increasing grade levels; however, Glick's (1970) school year data did not indicate a consistent pattern of decrease or increase. As with science, attitude and achievement do not seem to be strongly related in the school studies. Unlike the science studies, females tended to be more positive about school than males. However, the researchers seemed to question the definitiveness of the interpretation. They felt that socially it is unacceptable for girls to show their discontent, thus this finding may not be an accurate portrayal of females' true attitudes toward school. If this supposition is correct, how should females having less positive attitudes toward science than males be interpreted? Are females answering according to cultural norms? Finally, research is sorely lacking on the

question of whether students' attitudes toward school and science are related. The results of the studies on this topic were contradictory, with two indicating no relationship and the another suggesting the existence of one.

As mentioned in the previous summary sections, the instruments used in many of the studies either did not appear to have validity and reliability or no information concerning these properties were presented. Perhaps a reason for the discrepancies and lack of clarity in results is due to the use of presumably faulty attitude instruments. Another problem, though not as common, was incorrect statistical analyses of the data.

In contrast, this study used instruments shown to be valid and reliable. Particular care was given to the content validity of the instruments, a problem that surfaced repeatedly in past studies. Correct statistical procedures were used in analyzing the results. Also, students from elementary, middle, and high schools were surveyed to yield a wide spread of data, spanning the full range of students' exposure to science, for all intents and purposes. In addition, student interviews were conducted to enrich the collected data. Given these precautions, and using the other studies as a guide, the data gathered by this research project should help broaden

and clarify our understanding of students' attitudes toward science.

CHAPTER III. DESIGN AND METHODS

Introduction

In order to address the thesis questions, a number of variables must be examined; namely, attitudes toward school, attitudes toward science, grade level, ethnicity, gender, self-reported achievement, personal satisfaction with achievement, and type of school/community environment. The nature of these variables dictates the sample and instruments needed. This chapter explains the selection of the student sample, the choice of attitude instruments, and the process of data collection. It also outlines how the data were analyzed.

To reiterate, the main question in this research was whether students' attitudes toward classroom science are related to their attitudes toward school. The influence of grade level, ethnicity, gender, self-reported achievement, personal satisfaction with achievement, and type of school/community environment on this relationship were also examined. In addition, the influence of these variables on each attitude (school and science) was inspected.

Selection of the Sample

The research questions involved grade levels and type of school/community environment. Accordingly, the sample

for this study included elementary, middle school, and high school students from districts representing rural, urban, and small city communities. Although the NAEP surveyed students in grades 3, 7, and 11, the students for this study were in grades 5, 7, and 10. These latter grades were considered more appropriate for the purposes of this research for the following reasons. Fifth grade was chosen as the representative elementary school grade because it is close to the end of the elementary school experience. Since the amount of science taught in elementary grades varies greatly, it was hoped that by fifth grade these students would have had a sufficient exposure to school science to have formed an "informed" attitude toward the subject. Seventh graders were chosen to represent the middle school contingent because most of the research done on both school and science attitudes show a dramatic drop in seventh graders' attitudes. Finally, tenth graders were chosen for the high school sample so the collected data would represent students' attitudes after at least one year of high school science. Not all districts require students to take science in ninth grade, and not all students opt for a science class in this year. In addition, most students do not take science beyond tenth grade. Eleventh and twelfth graders would, therefore, not be representative of the high school population.

One variable examined was the school/community environment. The schools sampled were a rural, a small city, and an urban community. A representative elementary, middle, and high school were targeted from each community type. It was expected that all the fifth, seventh, and tenth graders from the selected schools would have an opportunity to participate in the study. Because the public schools in Oregon are not segregated by gender, no special attention was given during district selection to the number of males and females in the classes.

Instrumentation

One of the main problems with much of the research on attitudes has been the use of instruments that are neither reliable nor valid. As will be detailed below, the surveys used in this study were shown to be valid, reliable measures of students' attitudes toward school and toward science.

Because no satisfactory instrument to measure students' attitudes toward school was found, one had to be developed for the purposes of this study. The resultant questionnaire consisted of 10 statements to be responded to using a Likert-type five response scale (see Appendix A). The construction of the items was done in accordance with the accepted techniques outlined by Munby (1983b) and elucidated by Misiti, Shrigley, and Hanson (1981).

Specifically, the attitude object was defined as how favorably or unfavorably students feel about school. These feelings pertain to school in general and to the value of schooling. Attitude toward school is independent of attitudes concerning specific factors in the school environment such as the teachers, school administration, school subjects, peers, or the classroom environment. Each item had the attitude object embedded in it. The items represented statements of attitude and not cognition. Emotion-laden verbs were used. Finally, the statements were written with a simple vocabulary.

A panel of five professionals (two teacher educators and three public school teachers, one each from elementary, middle, and high school) was used to determine the face and content validity of the measure. Each member of the panel was given the detailed definition of attitude toward school noted above. All items received 100% agreement by the panel as reflective of the stated attitude objective.

Construct validity is much more difficult to achieve. No apparent way existed to separate a sample similar to the population for this study into two or more groups which logically should differ on their attitude toward school to test whether the instrument differentiates between them. Research has not shown that a strong

relationship exists between attitude and other discernible characteristics.

The instrument was used in a pilot study. From this study, face validity was determined by a sample of students. Details are provided in the pilot study section. Reliability was determined for the pilot sample using Cronbach's Coefficient Alpha. The instrument was shown to be reliable ($\alpha = .90$).

Students' attitudes toward science were measured using the Science Attitude Scale for Middle School Students, designed by Misiti, Shrigley, and Hanson (1991). This instrument is a Likert scale containing 23 items. Although it was used originally with students in grades 5-8, Shrigley (personal communication, January, 1991) felt the questionnaire would be an appropriate measure to use with high school students. The instrument was found to have content and construct validity. Content validity was determined by a jury of science teachers, a jury of middle school students, and by careful construction of the instrument so the attitude object would be embedded in each statement. Construct validity was ascertained using a variety of techniques. The authors indicated their claim that the instrument had construct validity was based on a known groups test, divergent validation, cross-cultural data, high alphas, high item-total correlations, and tests for evaluative quality. The coefficient alphas

were .96 and .92 for a white and Hispanic population, respectively. Reliability was established for the sample in the pilot study (Cronbach's alpha = .95).

Pilot Study

A pilot study was conducted to determine the reliability of both attitude instruments before using them in the research study. This pilot was necessary to ensure both instruments could be used at all three grade levels. The sample for this pilot study included 12 classes, representing the fifth, seventh, and tenth grades from representative community environments. The teachers of the pilot study classes spoke with two to three of their students to determine the students' reactions to the questionnaires. The students had no apparent trouble understanding any of the statements on the questionnaire and generally felt the survey items were pertinent to the attitudes in question. In the pilot study, the surveys took 10-15 minutes to administer.

Collection of Data

Schools that best met the needs of the study were targeted for data collection. The necessary approvals were received from the Oregon State University Human Subjects Board, the districts, and the schools' administration, which required that only volunteers could

be used. Since no special skill was needed to administer the surveys, the classroom teachers gave the questionnaires to their students. The teachers were given a script to read to maintain standardization in administering the surveys (see Appendices B and C).

Attitude Instruments

By design, the attitude instruments were to be administered during a neutral school period, such as homeroom. This procedure would have served two purposes: reduction of any influence a particular class has on a student's responses on the attitude questionnaire, and ease of data collection for all students at a particular grade level. Many schools were able to accommodate this request; however, because of scheduling conflicts, some schools administered the questionnaires in science classes.

The school attitude instrument and the attitude toward science questionnaire were administered simultaneously early in the school year (the first full week of school) and again near the end of the first quarter (the eighth week). Since attitudes are believed to remain consistent over time (unless something specific occurs in the students' environment to cause a change), there was only one major consideration in determining the time interval between questionnaire administrations.

Sufficient time needed to lapse between administrations so the students would not be unduly influenced by the first administration. That is, it was important that the students answered honestly both times and not attempt to answer the second questionnaire administration by recalling their previous responses. Based on his research, Koballa (personal communication, April, 1991) identified a three-week interval between testings as sufficient; the one-term interval in this study was appropriate. Also, the schools were given a several day range over which to administer the surveys. This flexibility allowed the schools to "fit" the testing in with their usual procedures, minimizing disruption of the school day.

The questionnaires were printed on Scantron sheets for ease in data analysis. These sheets also asked for information on the students' ethnicity, gender, and grade level. The instruments completed by the students in grades 7 and 10 had a place to note the science classes these students had completed or in which they were presently enrolled. The latter data were collected for informational purposes. In addition, four questions were added to the 33 attitude items on the seventh and tenth grade response sheets; namely, what science grade and school grade point average (GPA) students' expected and what grade and GPA would satisfy them.

Interviews

Shortly after the second administration, the data from the two questionnaires were compared. Based on the questionnaire responses, a sample of students from each grade level from each community type was selected as potential interviewees. The attitude toward science scale results were the main focus for student selection. The initial list was comprised of students whose attitudes toward science or school had changed during the two survey administrations and those with highly positive, strongly negative, and neutral attitudes toward science. A list of the "selected" students was submitted to the appropriate school administration. From the list, each administrator chose three students, based on their willingness to talk with the researcher, the students' schedules, and parental consent. This method of interview selection was chosen as the least disruptive to both the school and the students' learning time.

In all, 25 students were interviewed. This number represented three students from each grade level from each community type, with the exception of the tenth grade from the small city environment. The administrator was unable to find three students willing to be interviewed. Originally, two interviews were scheduled; however, on the day of the interview, one of the students changed her mind. Consequently, only one student volunteer

representative of the small city tenth grade was interviewed.

The interviews were conducted in November and December. The students were interviewed for approximately 20 minutes using a structured interview format. For ease in data collection, the interviews were audiotaped. The purposes of the interviews were to ascertain the students' actual interpretation of the survey items and to delve more deeply into why they felt as they indicated. Aside from reviewing questionnaire items and student's answers to ensure the student understood the items, the following interview questions formed the basis of the interviews:

How do you feel about school/classroom science?

Why do you feel this way about school/classroom science?

Do you think you should like school/classroom science? What do you see as the advantages? The disadvantages?

Are there any people who you think would want you to like school/classroom science? Any who would rather you didn't like school/classroom science? Do these people influence how you feel about school/science?

Have you always felt the way you presently do about school/classroom science? If not, what event(s)/people caused you to change your feelings? If so, why have your feelings remained consistent?

Think of a time you liked/disliked school/classroom science. Describe these experiences.

Is there anything that would change how you feel about school/classroom science?

What, if anything, would you change about school/classroom science?

Do you think what you're learning in school/classroom science is important? Why?

Are you pleased with the grades you are earning in school/science?

Hypotheses

The null hypotheses tested in this study were:

Ho₁: No significant relationship exists between students' attitudes toward science and students' attitudes toward school.

Ho₂: No significant relationship exists among attitudes toward science and attitudes toward school and grade level, ethnicity, gender, type of school/community environment, expected overall school and science achievement scores, and student personal satisfaction with those scores.

Ho₃: No significant relationship exists between students' attitudes toward school and grade level, ethnicity, gender, type of school/community environment, expected overall school achievement, and student personal satisfaction with that achievement.

Ho₄: No significant relationship exists between students' attitudes toward science and grade level, ethnicity, gender, type of school/community environment, expected science achievement, and student personal satisfaction with that achievement.

Data Analyses

The unit of analysis for this study was the individual student. Both attitude instruments were scored using the same method. Each statement had a value of 1-5. If the statement was worded negatively, one point was awarded to strongly agree, two to agree, three to undecided, four to disagree, and five to strongly disagree. If the statement was worded positively, the scoring was reversed with strongly agree awarded five points and strongly disagree given one. Scores on these scales could range from 10-50 on the Attitude Toward School instrument and from 23-115 on the Attitude Toward Science scale, with high scores being indicative of positive attitudes. A percentage of the students (less than 20%) left questions blank on the survey, with the greatest majority leaving one question unanswered on the school attitude survey or one to two questions blank on the science attitude portion. Rather than remove these students from the sample, their scores were proportionately altered for comparisons with students who had completed the questionnaires. That is, the ratio of the point values of the student's responses to the total point value possible for the number of questions answered was made proportional to the points the student would have "received" if all the questions were answered. Some students (about 1%) forgot to turn over the questionnaire

sheet; and, consequently, did not complete more than 70% of the science attitude portion. Those partial responses were not used in making analyses.

The two administrations of the survey were analyzed separately. Rather than averaging the survey results or combining them in any way, it was felt analyzing the administrations separately would (a) reflect whether attitudes toward school/science were indeed consistent from the start to the end of the first school term, and (b) assist in the selection of students to be interviewed in the event any attitudes did change. In addition, since the number of variables being measured differed between the fifth and the upper grades, the analyses were performed for each grade level rather than for the total sample.

The survey scores and corresponding grade level, ethnicity, gender, school/community environment, and achievement data were statistically analyzed. Multiple regression analyses (stepwise) were used to test most of the research hypotheses. Product-moment correlation coefficients were also computed, and ANOVA and Scheffe tests when appropriate.

The interview data were qualitatively analyzed, focusing on the factors that shaped attitudes. The compatibility of the student verbal and written responses were used to further assess the validity of the

questionnaires, as well as for a more in depth analysis of the sources of students' attitudes and possible sources of change.

CHAPTER IV. RESULTS

Sample

Prior to the start of the 1991-92 school year, the principals of the schools involved in the study were contacted to ascertain the number of surveys needed for the participating students. In all 1,521 surveys were sent to the nine schools involved in the study. A total of 1,015 surveys was returned after the first questionnaire administration. (An accurate return rate could not be computed. Several principals said they boosted the number to ensure they would have "extra" questionnaires in case students made mistakes. Other administrators guessed at the number of students that would be enrolled since registration was still in progress. For example, the administrators at the small city high school estimated they would need between 300-400 questionnaires; they were sent the latter.) The majority of the respondents were caucasian (90%). Four hundred eighty nine respondents were male and 514 were female. Twelve students did not indicate their gender. Table 1 presents a breakdown of the first survey responses by grade level and community type.

A total of 869 surveys was returned after the second questionnaire administration. Again, the great majority

of the respondents were caucasian (89%). Three hundred seventy four respondents were male and 429 were female.

Table 1

Number of Students Responding to the First Survey
Administration by Grade and Community Type

Location	Grade		
	Five	Seven	Ten
Urban	53	206	152
Small City	52	150	258
Rural	55	48	41

Sixty six students did not indicate their gender. Table 2 presents the responses by grade level and community type for the second survey administration.

The loss of respondents from the first to the second questionnaire administrations was due to the transfer of students into and out of schools, absenteeism, and teachers neglecting to give the surveys to their classes. No reason existed to suggest the second set of respondents was significantly different than the first. In addition, the sample remained representative of the targeted grade levels and school/community type.

For the first survey administration, all locations were approximately equally represented in the fifth

Table 2

Number of Students Responding to the Second Survey
Administration by Grade and Community Type

Location	Grade		
	Five	Seven	Ten
Urban	56	174	39
Small City	67	99	308
Rural	48	44	34

grade sample. For the seventh grade, as one might expect, the number of students participating increased as one moved from a rural, to a small city, to an urban school environment. The pattern shifted in tenth grade, with the small city school being more heavily represented than the others. Again, the rural school had the least number of tenth grade participants. A probable explanation for the small number of urban area tenth grade participants was that only those tenth graders enrolled in a science class were given the opportunity to participate in the survey.

The numbers shifted for the second administration. The fifth grade was no longer balanced as an increase in student participation occurred in both the urban and small city schools, and a decrease occurred in the rural location. For the seventh grade, all schools showed a decrease in the number of participants, but the pattern remained the same as with the first administration. The tenth grade pattern was radically different. Due to a lack of cooperation on the part of one of the teachers, the urban tenth grade had substantially fewer students participating in the second administration than in the first administration. In addition, the small city student participation increased.

The instruments were found to be highly reliable. Cronbach's alpha for the attitude toward school survey was .86 for the first administration and .87 for the second. The alpha coefficient for the attitude toward science survey was .93 for the first administration and .95 for the second.

Relationship between School and Science Attitudes

The first null hypothesis tested was that no significant relationship exists between student attitudes toward science and student attitudes toward school. Pearson's Product Moment Correlation Coefficients were computed to determine the relationship between students'

attitudes toward school and classroom science for each grade level and for the overall samples. The significance level for these analyses was set at .05. The coefficients were significant ($p < .001$) for each grade level and for the overall comparison in both survey administrations. The coefficients are listed in Table 3. (Descriptive data for students' attitudes toward school and science are presented and discussed later. Tables 11 and 13 list the attitude scores for students at each grade level for school and science, respectively.)

The null hypothesis was rejected. A statistically significant relationship was found between students' attitudes toward science and students' attitudes toward school. However, the actual explained variance (r^2) ranged only from 11-27%.

Table 3

Product Moment Correlation Coefficients for the
Relationship between Students' Attitudes toward School and
Classroom Science by Grade Level for Each of the Survey
Administrations

Administration	Grade			Overall
	Five	Seven	Ten	
First	.33*	.39*	.52*	.44*
Second	.46*	.37*	.44*	.44*

*p < .001

Relationships Among Attitudes and Other Variables

The second null hypothesis was that no significant relationship exists among attitudes toward science and attitudes toward school and grade level, ethnicity, gender, type of school/community environment, overall school and science self-reported achievement scores and student personal satisfaction with those scores. Multiple regression analyses (stepwise) were used to test this hypothesis. One set of analyses was performed using science attitude as the dependent variable, and a second

set of analyses was performed using school attitude as the dependent variable. The independent variables included gender, ethnicity, school/community type, and one of the attitudes. For seventh and tenth grade analyses, the expected GPA and science grade as well as the GPA and science grade the students would be pleased with were included as independent variables. The significance level for these analyses was set at .05. In all cases, no interaction effects were evident.

Fifth Grade Analyses

For the first questionnaire administration, using science attitudes as the dependent variable, only attitudes toward school were found to be significantly related to science attitudes, $F(1, 153) = 18.45, p < .00$. However, attitudes toward school accounted for only 10.76% of the explained variance in attitudes toward science.

The results of the analysis for the second administration were similar to the first. Again, attitudes toward school was the only variable found to be significantly related to science attitudes, $F(1, 160) = 42.88, p < .00$. In contrast to the first administration, attitudes toward school now accounted for 21.14% of the variance in attitudes toward science.

Performing the regression analyses with attitudes toward school as the dependent variable provided slightly

different results. For the first set of data, both attitudes toward science and gender were included in the model, $F(2, 152) = 12.41$, $p < .00$. The second set of data yielded similar results: attitudes toward science and gender were significant variables, $F(2, 159) = 26.31$, $p < .00$. The individual t -values, significance levels, and R -squared increments are presented in Table 4.

Table 4

Summary of Multiple Regression Analysis for Fifth Graders' Attitudes toward School (First and Second Questionnaire Administrations)

Source	t	p	R ² Increment
<hr/>			
First Administration			
Attitudes toward Science	4.39	.00*	.11
Gender	2.41	.02*	.03
Second Administration			
Attitudes toward Science	6.56	.00*	.21
Gender	2.81	.01*	.04

* $p < .05$

Seventh Grade Analyses

For the first questionnaire administration, using science attitudes as the dependent variable, three factors were included in the model: attitudes toward school, expected science grade, and school/community type, $F(3, 346) = 40.71, p < .00$. As with the fifth grade data, the second set of seventh grade data paralleled the first. Attitudes toward school, expected science grade, and school/community type were again the significant variables, $F(3, 201) = 22.22, p < .00$. The individual t -values, significance levels, and R -squared increments are presented in Table 5.

Performing the regression analyses with attitudes toward school as the dependent variable provided a different model. For the first set of data, three variables were found to be significantly related to attitudes toward school; namely, attitudes toward science, gender, and the school GPA the student would be pleased to receive, $F(3, 346) = 27.90, p < .00$. The variables found to be significant for the second administration were attitudes toward science, expected GPA, and gender, $F(3, 201) = 24.25, p < .00$. Table 6 lists the individual t -values, significance levels, and R -squared increments.

Table 5

Summary of Multiple Regression Analysis for Seventh
Graders' Attitudes toward Science (First and Second
Questionnaire Administrations)

Source	t	p	R ² Increment
First Administration			
Attitudes toward School	7.17	.00*	.16
Expected Science Grade	6.11	.00*	.09
School/Community Type	2.08	.04*	.01
Second Administration			
Attitudes toward School	5.40	.00*	.17
Expected Science Grade	3.79	.00*	.04
School/Community Type	2.87	.00*	.03

*p<.05

Table 6

Summary of Multiple Regression Analysis for Seventh Graders' Attitudes toward School (First and Second Questionnaire Administrations)

Source	t	p	R ² Increment
First Administration			
Attitudes toward Science	8.46	.00*	.16
Gender	2.85	.00*	.02
Satisfactory GPA	2.33	.02*	.01
Second Administration			
Attitudes toward Science	6.17	.00*	.17
Expected GPA	3.51	.00*	.05
Gender	3.24	.00*	.04

* $p < .05$

Tenth Grade Analyses

For the first questionnaire administration, using science attitudes as the dependent variable, four sources were found to be significantly related to attitudes toward science. These variables were attitudes toward school, expected science grade, school/community type, and gender, $F(4, 420) = 52.30, p < .00$. The results of the second questionnaire administration were quite different from the

first. Only attitude toward school was included in the model, $F(1, 293) = 74.42$, $p < .00$. The individual t -values, significance levels, and R -squared increments are presented in Table 7.

Using attitudes toward school as the dependent variable produced different models. Analysis of the data from the first administration showed attitudes toward science, expected GPA, and gender to be significant variables, $F(3, 421) = 72.23$, $p < .00$. For the second

Table 7

Summary of Multiple Regression Analysis for Tenth Graders'
Attitudes toward Science (First and Second Questionnaire
Administrations)

Source	t	p	R ² Increment
<hr/>			
First Administration			
Attitudes toward School	10.82	.00*	.26
Expected Science Grade	4.52	.00*	.04
School/Community Type	-3.86	.00*	.02
Gender	-2.67	.01*	.01
Second Administration			
Attitudes toward School	8.63	.00*	.20

* $p < .05$

administration's data, attitudes toward science, satisfactory GPA, and expected science grade were found to be significantly related to attitudes toward school, $F(3, 291) = 33.78, p < .00$. Individual t -values, significance levels, and R -squared increments can be found in Table 8.

The null hypothesis was rejected. Statistically significant relationships were found among attitudes

Table 8

Summary of Multiple Regression Analysis for Tenth Graders' Attitudes toward School (First and Second Questionnaire Administrations)

Source	t	p	R ² Increment
First Administration			
Attitudes toward Science	11.63	.00*	.26
Expected GPA	5.31	.00*	.05
Gender	4.13	.00*	.03
Second Administration			
Attitudes toward Science	7.78	.00*	.20
Satisfactory GPA	2.79	.01*	.04
Expected Science Grade	2.24	.03*	.01

* $p < .05$

toward science, attitudes toward school, and two to four of the other variables, depending on grade level and questionnaire administration.

Relationship between School Attitudes and Other Variables

The third hypothesis tested was that no significant relationship exists between students' attitudes toward school and grade level, ethnicity, gender, type of school/community environment, overall self-reported school achievement, and personally satisfying GPA. Multiple regression analyses (stepwise) were used to test this hypothesis. Analysis of variance and Scheffe tests were also used when appropriate. The regression analyses were done using attitude toward school as the dependent variable and gender, ethnicity, and school/community type as the independent variables. For the seventh and tenth grade analyses, self-reported GPA and the personally satisfying GPA were also included as independent variables. The significance level was set at .05. In all cases, no interaction effects were evident.

Fifth Grade Analyses

For the first survey administration, only gender was found to be significantly related to students' attitudes toward school, $F(1, 153) = 4.99$, $p < .03$, $R\text{-squared} = .03$. Analysis of Variance showed significant differences

existed between genders, $F(1, 157) = 5.07$, $p < .03$, with females ($M = 42.49$) possessing more positive attitudes than males ($M = 40.20$).

The results of the second administration were similar to the first. Again, gender was the only significant variable in the equation, $F(1, 162) = 7.24$, $p < .01$, $R^2 = .04$. Analysis of Variance of attitude toward school by gender yielded a significant difference, $F(1, 165) = 8.08$, $p < .01$. Again, females ($M = 42.79$) possessed a more positive attitude than males ($M = 40.53$).

Seventh Grade Analyses

For the first questionnaire administration, two variables were included in the model, $F(2, 352) = 8.02$, $p < .00$; namely, expected GPA and gender. These same variables were found to be significant in the second survey administration, $F(2, 228) = 16.81$, $p < .00$. The individual t -values, significance levels, and R -squared increments are presented in Table 9.

Analyses of Variance were performed on these variables. For the first administration, expected GPA was shown to be significant, $F(3, 371) = 4.51$, $p < .00$. A Scheffe test showed those expecting to get a 4.0 ($M = 41.40$) were significantly more positive than those expecting to receive a 1.0 ($M = 34.88$). Gender was shown

Table 9

Summary of Multiple Regression Analysis for Seventh
Graders' Attitudes toward School (First and Second
Questionnaire Administrations)

Source	t	p	R ² Increment
First Administration			
Expected GPA	3.39	.00*	.03
Gender	2.09	.04*	.01
Second Administration			
Expected GPA	4.41	.00*	.09
Gender	3.26	.00*	.04

* $p < .05$

to be a significant factor with respect to attitudes toward school, $F(1, 399) = 6.53$, $p < .01$, with males ($M = 38.82$) again possessing a less positive attitude than females ($M = 41.00$).

The ANOVAs for the second administration were similar. Expected GPA was found to be significant, $F(3, 245) = 9.06$, $p < .00$, with a Scheffe test indicating those expecting to receive a 1.0 ($M = 31.33$) being less positive than those expecting a 3.0 ($M = 38.96$) or a 4.0 ($M = 41.27$). In addition, those who expected a 2.0 ($M = 36.65$)

were also significantly less positive than those expecting a 4.0. Gender differences were also significant, $F(1, 307) = 17.30$, $p < .00$, with females ($M = 40.26$) again more positive than males ($M = 37.22$).

Tenth Grade Analyses

As with the seventh graders, tenth graders' attitudes toward school were significantly related to both expected GPA and gender for both the first [$F(2, 423) = 30.46$, $p < .00$] and second [$F(2, 295) = 15.46$, $p < .00$] survey administrations. The individual t -values, significance levels, and R -squared increments are presented in Table 10.

The ANOVA for the first administration examining students' attitudes toward school and expected GPA found the latter to be significant, $F(3, 440) = 17.35$, $p < .00$. A Scheffe test indicated that those expecting a 4.0 ($M = 42.51$) were significantly more positive than those expecting a 3.0 ($M = 40.08$), a 2.0 ($M = 36.77$), or a 1.0 ($M = 32.33$). In addition, those expecting a 3.0 were significantly more positive than those expecting a 1.0 or a 2.0. Gender was also found to be significant, $F(1, 441) = 11.93$, $p < .00$, with females ($M = 41.35$) more positive than males ($M = 39.95$).

Table 10

Summary of Multiple Regression Analysis for Tenth Graders'
Attitudes toward School (First and Second Questionnaire
Administrations)

Source	t	p	R ² Increment
First Administration			
Expected GPA	6.86	.00*	.10
Gender	3.19	.00*	.02
Second Administration			
Expected GPA	5.02	.00*	.08
Gender	2.25	.03*	.02

* $p < .05$

For the second administration, an ANOVA of attitudes toward school by expected GPA was significant, $F(3, 348) = 12.18$, $p < .00$. A Scheffe test showed those expecting a 1.0 ($M = 28.50$) to be less positive than those expecting a 2.0 ($M = 37.31$), a 3.0 ($M = 39.09$), or a 4.0 ($M = 40.94$). In addition, those expecting a 4.0 were also significantly different from those expecting a 2.0. Gender was also found to be significant, $F(1, 325) = 6.45$, $p < .01$, with males ($M = 37.84$) being less positive than their female counterparts ($M = 39.52$).

Analyses across Grade Levels

An ANOVA was performed on attitudes toward school by grade level. It was found that significant grade level differences existed: $F(2, 1012) = 3.77$, $p < .02$ for the first administration; $F(2, 866) = 12.83$, $p < .00$ for the second. A Scheffe test on the first set of data indicated fifth graders were significantly more positive than seventh graders. For the second administration's data, fifth graders were significantly more positive toward school than both seventh and tenth graders. No significant differences were found between the two upper grades in either administration. Means and standard deviations for the grade levels' school attitudes are listed in Table 11.

A paired t-test was used to determine whether students' attitudes toward school had changed from the first to the second survey administration. Although a significant difference was found, $t(500) = 3.60$, $p < .00$, the actual mean difference was 0.79 points ($M = 40.68$, $SD = 5.41$ for the first administration; $M = 39.89$, $SD = 6.24$ for the second). The third null hypothesis was rejected. Statistically significant relationships were found among attitudes toward school and two to three of the other variables, depending on grade level and questionnaire administration.

Table 11

Mean Scores of Students' Attitudes toward School for Each Grade Level for Both Survey Administrations

Administration	Grade		
	Fifth	Seventh	Tenth
First			
<u>M</u>	41.33	39.88	40.09
<u>SD</u>	5.80	5.70	5.80
<u>N</u>	160	404	451
Second			
<u>M</u>	41.40	38.70	38.72
<u>SD</u>	5.97	6.60	6.03
<u>N</u>	171	317	381

Relationship between Science Attitudes and Other Variables

The fourth hypothesis tested was that no significant relationship exists between students' attitudes toward science and grade level, ethnicity, gender, type of school/community environment, self-reported science achievement, and personally satisfying science grade. Multiple regression analyses (stepwise) were used to test

this hypothesis. Analysis of variance and Scheffe tests were also used when appropriate. The regression analyses were done using attitude toward science as the dependent variable and gender, ethnicity, and school/community type as the independent variables. For the seventh and tenth grade analyses, self-reported science grade and the personally satisfying grade were also included as independent variables. The significance level was set at .05. In all cases, no interaction effects were evident.

Fifth Grade Analyses

For both questionnaire administrations, none of the independent variables was found to be significantly related to students' attitudes toward science.

Seventh Grade Analyses

The results of the analysis for the first questionnaire administration indicated one variable was significantly related to students' attitudes toward science; namely, expected science grade, $F(1, 358) = 58.92$, $p < .00$, $R^2 = .14$. Analysis of variance indicated there was indeed significantly more variance between groups expecting different science grades than within groups, $F(4, 376)$, $p < .00$. A Scheffe test showed that those expecting to receive an "A" in science ($M = 75.64$) had significantly more positive attitudes than those

expecting a "C" ($\bar{M} = 61.31$), "D" ($\bar{M} = 49.70$) or "F" ($\bar{M} = 47.25$) In addition, those expecting to receive a "B" in science ($\bar{M} = 65.21$) were significantly more positive than those expecting to receive a "D" or "F."

For the second administration, both expected science grade and school/community type were found to be significant variables, $F(2, 213) = 17.86$, $p < .00$. Expected science grade accounted for 11% of the variance, $t = 5.41$, $p < .00$. School/community type accounted for an additional 4% of the variance, $t = 3.05$, $p < .00$.

Analysis of variance of attitudes toward science by expected science grade indicated significant differences did exist, $F(4, 227) = 7.78$, $p < .00$. A Scheffe test showed that those students expecting to receive an "A" ($\bar{M} = 69.07$) were significantly different than those expecting to receive a "D" ($\bar{M} = 49.39$) or "F" ($\bar{M} = 43.13$).

Analysis of variance confirmed that the school/community types were significantly different with respect to attitudes toward science, $F(2, 308) = 3.27$, $p < .04$. However, a Scheffe test showed that no two locations were significantly different at the .05 level. The means for the urban, small city, and rural seventh graders were 60.82, 64.34, and 67.93, respectively.

Tenth Grade Analyses

For the first questionnaire administration, expected science grade and school/community type were found to be significantly related to students' attitudes toward classroom science, $F(2, 427) = 36.41, p < .00$. The individual t -values, significance levels, and R -squared increments are presented in Table 12. These two variables were further explored using ANOVAs. Significant differences with respect to science attitudes were found among groups with different expected science grades, $F(4, 442) = 16.91, p < .00$. A Scheffe test indicated that those expecting to receive an "A" ($M = 74.45$) possessed more positive attitudes than those expecting a "B" ($M = 65.35$), "C" ($M = 61.33$), "D" ($M = 59.64$) and an "F" ($M = 48.33$). Mean differences ranged from 9.09-26.12. Location was also found to be significantly different, $F(2, 444) = 8.81, p < .00$. Students in the urban school possessed significantly more positive attitudes ($M = 71.90$) than those in either the small city ($M = 65.85$) or rural ($M = 63.66$) community.

Analysis of the data from the second administration indicated these same two variables as being significant, $F(2, 298) = 9.19, p < .00$. The individual t -values, significance levels, and R -squared increments are presented in Table 12. An ANOVA found a significant difference among groups expecting different science

grades, $F(4, 352) = 3.50$, $p < .01$; however, a Scheffe test showed no two groups were significantly different at the .05 level. Location was shown by ANOVA to be significant, $F(2, 369) = 3.61$, $p < .03$. Scheffe tests showed that those students in the urban school/community type ($M = 68.03$) possessed more positive attitudes than those in the rural community ($M = 57.41$).

Table 12

Summary of Multiple Regression Analysis for Tenth Graders' Attitudes toward Science (First and Second Questionnaire Administrations)

Source	t	p	R ² Increment
<hr/>			
First Administration			
Expected Science Grade	7.47	.00*	.12
School/Community Type	-3.88	.00*	.03
Second Administration			
Expected Science Grade	3.61	.00*	.04
School/Community Type	-2.19	.03*	.02

* $p < .05$

Analyses across Grade Levels

An ANOVA was performed on attitudes toward science by grade level. It was found that significant grade level differences existed: $F(2, 999) = 21.40, p < .00$ for the first administration; $F(2, 848) = 47.41, p < .00$ for the second. Scheffe tests on both administrations yielded the same results: fifth graders were significantly more positive toward science than both seventh and tenth graders. No significant differences were found between the two upper grades in either administration. Means and standard deviations for science attitudes by grade levels are listed in Table 13.

A paired t -test was used to determine whether students' attitudes toward science had changed from the first to the second survey administration. Although a significant difference was found, $t(493) = 3.74, p < .00$, the actual mean difference was 2.55 points ($M = 69.26, SD = 16.93$ for the first administration; $M = 66.71, SD = 18.69$ for the second). The fourth null hypothesis was rejected for seventh and tenth graders. Statistically significant relationships were found between attitudes toward science and two of the other variables. For the

Table 13

Mean Scores of Students' Attitudes toward Science for Each Grade Level for Both Survey Administrations

Administration	Grade		
	Fifth	Seventh	Tenth
First			
<u>M</u>	75.96	65.95	67.66
<u>SD</u>	19.69	16.20	15.65
<u>N</u>	160	394	448
Second			
<u>M</u>	77.58	62.92	63.16
<u>SD</u>	17.36	17.84	16.87
<u>N</u>	168	311	372

fifth grade, however, the null hypothesis was not rejected; no significant relationships were found between attitudes toward science and any of the other variables.

Collection of Interview Data

As noted earlier, nine fifth graders, nine seventh graders, and seven tenth graders were interviewed. The purposes for these interviews were to further assess the validity of the questionnaire and to attempt to learn more about the development of students' attitudes. The administrators were given a prioritized list of possible interviewees. The lists were compiled in such a manner that students with strongly positive attitudes, very negative attitudes, and those unsure of how they felt or who had changed their attitudes were represented. Theoretically, if the first three students on the list were interviewed, they would represent each of these views. Because the administrators (and, of course, the students and their parents) had the final say concerning who was to be interviewed, the majority of the interviewees held positive attitudes.

At various points in the interview, students were asked specific questions from the questionnaire. The oral responses generally matched the written responses. Two students tended to check "undecided" although they had some feelings about the items: one, because she tended to be conservative and the other because he was not enrolled in science and felt it would be unfair to write anything other than "undecided." In both cases, the students' oral

responses indicated a more positive attitude than their written responses.

The students were asked for their impressions of the items on the questionnaire. All felt the questions were straight-forward and not confusing. According to the students' own indication of how they felt about particular items and about their attitudes in general, the questionnaires accurately assessed students' attitudes toward school and classroom science.

Following the interview period, the audiotapes were transcribed and qualitatively analyzed. For ease in presentation, the reporting of results will follow the structured interview format. Themes that became apparent will then be presented.

Students' Attitudes Toward School

How Do You Feel about School? Why?

Six fifth graders, five seventh graders, and six tenth graders said they liked school. Three fifth and two seventh graders were undecided (sometimes they liked it and sometimes they did not like it), and two seventh and one tenth grader definitely did not like school. The most common reason fifth graders gave for liking school was it was "fun." Fifth graders also liked school because it was challenging, as evidenced by these representative statements:

I look at it as a challenge. I like the work and it's just a lot of fun.

The best part of school is going to the TAG program, talented and gifted. You get to do a lot of brain work there.

One student said a reason for liking school was that it provided an opportunity to see peers. Some fifth grade students responded with specific subjects they liked to study in school. Finally, another reason fifth graders liked school was that they liked to learn. One girl remarked, "Because you can learn things that you didn't learn like that you wanted to learn before, that you wanted to know that you didn't know."

Seventh graders echoed some of the fifth graders' responses. They liked school because it gave them an opportunity to be with their friends, and they enjoyed learning. One seventh grader said, "Mostly, there's nice

teachers and friends, and sometimes the work's fun." A boy responded, "Being with my friends and sometimes the stuff that you learn is really neat." Note that the first quote also included "nice teachers" as a reason for liking school. One group of responses differed from fifth graders; namely, particular activities done in the class. One girl said, "I like tests. I like to see how I'm doing." A student, who sometimes liked school and sometimes did not, said, "The classes that I like, there's more, like I can move around and stuff. Not just sit at a desk and work and stuff."

The most vocalized reason for tenth graders liking school was social: they got to see their friends. Another common response was "It's better than sitting home, not doing anything." Learning things was also echoed by several students. One student did add that school was "fun."

No fifth graders disliked school. However, seventh graders gave the following reasons for disliking school: "boring teachers," subjects/work the students did not like, and a preference for being someplace else or "doing something else."

Only one tenth grader indicated she disliked school. "I think it's kind of boring. I don't really think it applies to--I think maybe it does apply, but they don't tell us how..."

Advantages and Disadvantages of Liking School

Almost all students felt they should like school. Although the questionnaire data did not show a practical relationship between achievement and attitude, across all grade levels students linked attitude with achievement; for example,

It's a little bit easier if you're more willing and when you like things you're usually a lot more willing.

If you don't like coming to school you um you won't learn as much cause like you'll be kind of shutting off.

Also common to all students was a belief that liking school would help the students with a career.

Fifth graders felt they should like school because it is where they get an education and it would help them do well in college. Some seventh graders felt liking school would help them get along with their teachers or enable them to make more friends. Tenth graders added that liking school makes it more fun and less stressful.

Who Wants You to Like/Dislike School?

When asked who would like them to like school, fifth graders responded with parents, family, specific family members (mother, brother), and teachers. The seventh graders responded similarly, but added friend, grandmother, and principal. Tenth graders responded parents, teachers, principal, adults, or everybody.

The list of those who would not want students to like school was substantially shorter. None of the seventh graders could think of anyone. A tenth grader suggested people who do not do well. Fifth grade responses included three groups: friends, people who don't like school, and teachers. Regarding "teachers," the student was asked how he knew they didn't want him to like school and his response was "they don't really give out assignments and they say that they're taking the pressure off of you."

Do These People Influence Your Feelings about School?

The students' feelings regarding the influence these groups of people had on their attitudes toward school were mixed. No fifth graders felt their friends influenced them. Most indicated they did not know how their friends felt about school. Some fifth graders felt the other groups (teachers, parents, family) influenced them while other students did not. Seventh graders also did not think they were influenced by their friends. They felt teachers were also not influential. As with fifth graders, some seventh graders felt their family influenced their feelings while others did not. Tenth graders had some students who felt influenced by friends, principals, teachers, and parents, and others who did not feel these groups had any effect on their attitudes.

Have Your Attitudes toward School Changed?

A number of students at each grade level felt their attitudes toward school had changed. Fifth graders' attitudes became more positive when there was a change in teachers and when a student felt she "got ahead." For one student, attitudes toward school declined after kindergarten because there was less opportunity for "hands-on" activities.

Seventh graders' attitudes declined due to particular teachers, the work getting harder, and getting in trouble. Better relationships with peers improved the attitude of one student.

Tenth graders' attitudes improved due to an increase in socialization, a greater feeling of school spirit in high school, and the opportunity to have different teachers and different classes in high school. As with the other two grades, experiences with particular teachers was also responsible for a change in tenth graders' attitudes toward school.

Describe a Time You Liked School.

Favorable school experiences of fifth graders centered around specific activities (projects, science fairs) or topics (learning division, doing science). One fifth grader recollected liking entering first grade because he got his own desk.

Seventh graders' responses were similar to the fifth graders. Most favorable experiences were activities (class trips, field trips). One student fondly remembered kindergarten because he got to play. Another liked the first day of school because he got to learn and he enjoyed learning. One seventh grader's favorite experience was taking tests.

Tenth graders were more varied with their responses. One student's favorite school experience was receiving crayons as a Christmas present from her third grade teacher. Another student's was doing a genetics lab. One student's most memorable day was getting an "A." Some liked the pep assemblies and field trips. The time just before Christmas break was the most favorable experience for one student. Another felt any time she was in a good mood made for a school day she enjoyed.

Describe a Time You Disliked School.

When asked to describe a time they disliked school, fifth graders identified: getting a "D," having an unfair teacher, getting detention, being sick in school, Monday mornings, missing school and needing to do the work on his own at home, and going to school when other schools in the area were closed. Seventh graders' responses were also varied. They were: not getting along with peers, having a day of all tests, getting hard assignments to do right

after a vacation, parent/teacher conferences, and the first day of school (because she was nervous). Also mentioned by seventh graders were days that school was boring and they did not learn much or just sat there and did work.

When the tenth graders described a school day they disliked, their responses included finals, first and/or last days of school, a day with no activities or assemblies, when work was too easy or the students just sat and listened, and having a mean teacher. One student said her worst days were coming to school when she is dealing with problems at home.

What Could Change Your Feelings about School and What Would You Like to Change about School?

Students were easily able to vocalize what could change how they feel about school and what they would like to change about school. Fifth graders said their achievement and teachers would affect their attitudes. Regarding what they would change, one fifth grader suggested having recess "all the time." Another wanted year-round school! One student would place recycling bins in the school. Another comment was to stop students from talking during class and get them to try harder. Several fifth graders mentioned they would incorporate more hands-on activities into their classes.

Seventh graders, like fifth graders, indicated achievement and teachers would affect their attitudes. They added friends, an increase in assignments, changing school rules, and going to school on Saturday. Similar to the fifth grade request for recess, two seventh graders wanted a shorter school day. A few wanted new teachers. Another suggestion was to change the way subjects were taught; there should be more hands-on activities and "they" should make school fun, such as by using computers more often.

Tenth graders, as the fifth and seventh graders, also mentioned achievement and teachers as sources of attitude change. They added friends and time for socializing, getting in trouble, getting rid of gangs, and having a longer lunch. Some mentioned the need for instruction to be more applicable.

Is What You Are Learning in School Important?

When questioned about the importance of what they were learning in school, fifth graders felt school was important for an education, their future, and a job. The seventh graders' responses were similar. They noted school was needed for jobs and for their future education. One also said school was necessary to teach them how to get along with others.

Tenth graders also felt education was important for jobs, their future, and to "learn stuff." One felt it must be important, but did not know why--"there must be some reason for it."

Several seventh and tenth graders indicated that some of what they learned in school was important and some was not. What constituted these categories seemed based on personal preference rather than anything else. One felt electives were worthless, another calculus, and a third, geometry.

Are You Pleased with Your Grades?

Almost all the seventh and tenth graders were happy with the grades they were receiving in school. The two students who were not satisfied with their grades indicated their performance was due to their own lack of effort.

Themes in Interview Responses about School

Socialization

Several themes were apparent in the students' interview responses. One was the importance of socialization to the tenth graders interviewed. While two fifth and two seventh graders mentioned seeing friends or peers as a reason for liking school, the majority of the

tenth graders included friendship when discussing why they liked or disliked school:

I like being at school because I'm with my friends.

Probably [feel] less positive if there's no pep assemblies or stuff.

When I was little I was kind of a misfit so I didn't like it a lot.

[I would change how I felt about school] if we didn't have any time to socialize. Just going to school and just being in classes isn't fun but getting to see everyone and talk to them and see what's going on with them. That's fun.

Attitudes toward School and Achievement

A number of responses from students at each grade level suggested that students felt there is a link between attitude toward school and achievement:

I like math because I'm really good at it.

If I didn't get good grades or something I probably wouldn't like school.

[I've liked school] ever since about second grade when I started to get ahead.

If you have a good attitude, you'll do better.

The classes I like I do better in.

Teacher Effects

Although the questions for the structured interview did not include any specific reference to teachers, most students commented about teacher(s) at some point in the interview. Even though "teachers" was not a dominant

response when the students were directly asked who influenced their attitudes toward school, teachers appeared to influence students in a variety of ways. Teachers were responsible for the students' like or dislike of school or particular subjects, changed the students' attitudes toward school, and affected the students' learning. Some of the comments about teachers were mixed in with the modes of instruction the teachers used:

There could be some things (that could change how I feel about school) like teachers that don't really care about how your work is done and if they make you not feel important then that would really turn somebody off from school.

My teacher (made me feel more positive about school). She's a real good teacher and she encourages us to do things and to try it and if we think we can't do it to try it and that really helps.

(I changed how I felt about school because) I had a really mean teacher and she made me do a lot of different things than teachers normally would so I got a different teacher and she was a lot nicer.

I liked being in (his) room. He made (school) fun because he'd do all kinds of neat projects and everything like that.

I used to like elementary because like in fifth grade we had a teacher who didn't really have any control over our classroom. We could just go everywhere we wanted and stuff.

I think math is (my favorite class). It's not because of the math; it's because of the teacher.

It's easier to learn when somebody else is happy to teach you.

If they're (teachers) trying to help you to like school, it's important to like school. It helps.

I didn't have really athletic ability and she (the PE teacher) looked down on kids that didn't...I just didn't like her. She didn't have the flow, you know...

Mode of Instruction

Students' attitudes also seemed influenced by the mode of instruction used by their teachers. Students appeared to like cooperative learning, hands-on activities, and games. For the most part, they did not like "passive" learning, such as listening to lectures and taking notes.

In kindergarten you do a lot of hands-on activities and it was really pretty fun.

He put us in groups a lot of the time and we didn't just do like fill out a sheet or anything. We did group activities and do, like, we made a lot of posters and stuff like that. And plays, we did a lot of plays.

(School work is fun) like when we uh not just do a paper. You like do projects instead of just writing down and doing all the answers out of the book. Like acting out what happens like in social studies or something like that.

(I liked school) when I was in elementary school cause like my teacher has you do lots and lots of activities and you can get up out of your seats and do stuff. You can work with partners and stuff. It was fun.

Well, maybe if they had more hands on stuff instead of reading, just sitting there reading books. Just to study it doesn't work. If they had more hands-on activities in each class it would be a lot funner.

(I don't like school) when you sit there and just listen to someone talk and talk and talk about the same thing.

Relevance of Courses

One final theme was apparent in the responses of the seventh and tenth graders interviewed. Some of these students questioned the need to study some of the areas they were required to in school. They did not see the purpose or relevance of some subjects.

I don't think that when I get older what I'll need to do, I didn't think it will mean anything because I don't think I need to know much about Egyptian people. I'm not Egyptian and never will be, you know. I don't care about Egyptians.

(Something I don't like about school is) required courses that have nothing to do with life in the outside world, like calculus and up in the higher grades and stuff. Calculus, I mean how are we gonna use calculus?...Why would you need calculus? You know. It doesn't make sense.

I mean like algebra, geez, it's just a problem. I mean if they gave you like a situation and you had to solve the situation, you know?...I mean, some of the classes are just so abstract.

It seems really pointless. I mean. Everybody learns (math) and stuff, you know. There must be some point, but I'm still trying to figure out what it is. I mean it's required and stuff, but I don't know. I'm not bad at it or anything, it's not like really hard or anything like that. I just don't see the point.

In contrast, one student's favorite class was social studies because she felt it was relevant:

In social studies we learn about what's going on right now. Current events. We have to turn in current events all the time and stuff. It's just fun. We learn about different countries in the world.

In summation, based on the students' comments, students' attitudes toward school were affected by their teachers, achievement, modes of instruction, and relevancy of subject matter. Social interactions were also important factors in influencing tenth graders' school attitudes. Most students felt favorably toward school and felt what they learned in school was important for their future, education, and career opportunities.

Students' Attitudes toward Science

How Do You Feel about Classroom Science? Why?

Seven fifth, seven seventh, and five tenth graders interviewed indicated they liked classroom science. One seventh grader was undecided, while one did not like science. Two each of tenth and fifth graders interviewed also did not like classroom science.

The overwhelming responses given by fifth graders to explain why they liked science was it was fun and they liked the hands-on activities. Also mentioned were specific topics, field trips, that science was interesting and educational and/or important for a career choice.

Seventh graders' main reason for liking science was also the lab activities. Two additional reasons were

field trips and specific topics. One felt it was easy, some liked the way the teacher taught the class, and others liked the group work involved in science class.

Tenth graders gave fewer responses for liking science. Some liked the topics. Others saw it as something "new" and educational. One student suggested it was fun. Some tenth graders liked the relevance they found in science:

I just want to learn more about what's out there, not just...I want to learn what is happening to us and the world, more than we just see on paper.

...the one thing I remember about science class, like, is talking about something about the color in animals' eyes when a light shines on them and I went, wow, I learned about that in biology class. It's like you can apply it to everyday life...

Reasons for not liking science were similar across the three grade levels for the students interviewed. Fifth graders felt it was boring and did not like the way they were taught. Seventh graders shared this sentiment and also included they felt it was hard, they had no background for it, it was not useful, and they did not like the teacher. Tenth graders echoed the responses of science being hard and boring. One said she was just not a "science person."

Advantages and Disadvantages of Liking Classroom Science

Some students at each grade level felt there were advantages to liking science. One fifth grader felt that "if everybody liked science then we'd have a bunch of smart people." Another felt he should like science because he "wants to learn science." Others felt they should like science because of its relevance:

You learn a little more about what your world looks like and things, because if you didn't know that, you couldn't do anything really.

There's a lot of stuff happening with science, like nuclear war. It's better to know science than not.

Some seventh graders felt an advantage to liking science would be an improvement in their science achievement. Relevance also was suggested: one felt it would help her with her career, while another felt it was important to like science for the following reason:

If you, like, become a parent, it helps you at home and stuff with doing different things, in knowing how things work like electricity and making dinners and things.

A seventh grader who did not like science felt he should like science because "if I were like a scientist, it would be better for the country and stuff."

Tenth graders felt liking science would enhance their science achievement. One student also felt empowered by science:

It'll definitely make grades you like a lot easier. Because if you like science and stuff

you get a sense of what's going to happen or might happen and if it does happen, I knew that! That was a possibility and it makes you feel secure that you knew what's gonna happen.

Who Wants You to Like/Dislike Classroom Science?

Fewer students came up with responses for who would want the students to like science than for who would want them to like school. Fifth graders felt their family (including parents, siblings and grandfather) and teachers wanted them to like science. Seventh graders felt their parents, science teachers, and scientists would. Tenth graders responded teacher, friends, and brother when asked who would like them to like science.

Fifth graders felt siblings and friends were those people who would not like them to like science. None of the seventh graders felt anyone wanted him/her to dislike science. One tenth grader felt people who do not do well in science would want them not to like it.

Do These People Influence Your Feelings about Classroom Science?

Fifth graders felt their family and teachers were influential in shaping the students' attitudes toward science. A seventh grader felt his father was influential, while another felt the teacher was. Tenth graders only felt influenced by teachers.

Have Your Attitudes toward Classroom Science Changed?

A few fifth and tenth graders felt their attitudes toward science had changed. The seventh graders felt their feelings were consistent. One of the fifth graders who changed his attitude felt it was due to a change in his interests: "I really like animals now so I like science a lot better." A second student felt the change she experienced was due to the mode of instruction being used:

I like it better because last year we didn't do any experiments but this year we already did an experiment, and I think we did one before but I'm not sure...

The conversation with another student who felt his attitude toward science had changed went as follows:

Student: I liked it at the beginning of the school year but now I hate it.

Interviewer: How come you liked it at the start?

Student: I don't know.

Interviewer: Did you learn something different than you're learning now?

Student: Probably because I forgot from last year.

Interviewer: Forgot what?

Student: How bad it was.

Tenth graders felt their attitude toward science changed because of a change in teachers and in topics covered in science class. Mode of instruction was also mentioned:

Last year the only thing I didn't like--it was general science--was all the note taking.

Last year it was kind of cool when we did experiments that really had a reaction but some of the things are so minute, you know, with the experiments and stuff, and I don't like reading and all that kind of stuff about that. Only the experiments.

Describe a Time You Liked Classroom Science.

Students were asked to describe a favorable experience in science class. The most common responses from all students across all grade levels (and the only responses from seventh graders) were a hands-on activity, followed by a field trip. Fifth graders also mentioned specific units they were studying. One tenth grader favorably remembered a middle school science class where she got to choose her own topic to study. A fifth grader had a telling remembrance:

Student: The day he had a major headache. We almost had to do science and he got over the headache and we went outside for recess.

Interviewer: So you never did get to do science?

Student: No. That was lucky.

Describe a Time You Disliked Classroom Science.

When asked about an experience in science class they disliked, fifth graders responded with specific topics or types of instructional activities (a boring lab, present and future dissections, and report writing).

Seventh graders' responses centered around instructional activities: too much work, writing up labs,

copying notes, lectures, worksheets, and book work. One student disliked getting in trouble and being assigned a report as punishment.

Tenth graders mostly did not like taking notes, when teachers "pack it all in one day," paperwork, and not understanding the lesson.

What Could Change Your Feelings about Classroom Science and What Would You Change about Classroom Science?

When asked what could change how the students felt about science, fifth graders replied changing topics and doing more hands-on activities. Seventh graders also wanted more experiments, less use of the text, and more field trips. A different teacher was also a reply. Tenth graders, like those in the other grades, wanted more labs and more field trips. One student commented she would like students who were more interested in the subject matter as it affected the work of the cooperative learning groups.

When asked what they would change about science class, all the students' responses dealt with curricula changes. Fifth graders wanted more exposure to science, more demonstrations, less reading, more hands-on activities, more equipment, up-to-date science films, dissections, and a concentration on favorite topics. The seventh graders wanted less reading, more experiments and field trips, up-to-date videos, dissections, a change in

topics, and an ability to pick their own partners for group work. One student's comment stressed the importance of visual aids:

Like when we were doing oceanography, they talked about anemones and we never found out what an anemone was until we went to the tide pools and stuff. Cause I knew all about it but I didn't know what it was.

Tenth graders would do less reading and more experiments, discussions, and group work. They felt teachers should use models, break the subject matter down into diagrams, and make the material more realistic. One student would change her "brain a little bit so (she) could understand things that are complex."

Because most of the students indicated they would want more hands-on activities in science class, the students were asked why they enjoyed laboratory work. Fifth graders felt it was fun and they enjoyed doing science. Seventh and tenth graders echoed these sentiments and added experiments either made science easier to learn or enabled them to learn more.

Is What You Are Learning in Classroom Science Important?

When asked if students felt what they're learning in classroom science was important, most of the fifth graders felt it was important only for those who wanted to become scientists. Two were uncertain: one thought it probably was but did not know why, another thought it might be

useful later in life. Some said it was important to know about the world about them and they could relate it to activities outside of school (eg. picking mushrooms, seeing moss and fungus when camping).

As with fifth graders, most seventh graders felt science was important if it related to one's career choice. One felt it was important to know chemical symbols (no reason given); another felt science was useful in her hobbies (making beaded bracelets and kites). As quoted earlier, one seventh grader felt science was useful in understanding how things worked in the home, and another appreciated knowing how to read a thermometer.

Three tenth graders felt it was important to study science because it helped them to know about and relate to the world around them. Most students, however, felt science was only important for those who wanted to pursue a career in science.

Are You Pleased with Your Science Grades?

Only one of the seventh or tenth graders indicated he was not pleased with the grade he was receiving in science. As with school, the student felt responsible for his performance.

Themes in Interview Responses about Classroom Science

Attitudes toward Science and Achievement

Several of the themes that were apparent from the students' comments about school were also evident from their comments about classroom science; specifically, the effect of attitudes on achievement, teachers, modes of instruction, and relevance. Although the students' sentiment that achievement was linked with one's attitudes toward classes extends logically toward science, many tenth graders made specific comments concerning achievement in science class and attitudes toward classroom science.

I think [science] is hard. I don't like it.

Because if you have a positive attitude about [science class], I mean, you can learn a lot.

A lot of time I think people don't say, well, they say usually you don't like something when you can't do it or when you don't understand it.

Teacher Effects

A particular science teacher a student had/has also appeared to be a consistent factor affecting students' attitudes toward classroom science. As with the apparent relationship between teachers and students' attitudes toward school, some of the comments about teachers were mixed in with the modes of instruction the teachers used:

I especially liked science in [his fourth grade teacher's] class. He had a grow lab in there and we had to record things about it and we'd go watch salmon spawn and we took a lot of field trips and stuff like that. That was fun.

[I don't like science] because it's pretty boring because my teacher hands out worksheets and some of you don't understand and stuff and you just sit there and do nothing.

Well our teacher, her husband taught biology at a college so she had a lot of things like that [visual aids] that she'd bring and show us so it was a lot of fun.

Last year I had a really cool teacher and he made science a lot of fun so I liked it last year...I hear if you have [him] it's pretty fun because he makes it pretty fun. I don't know about the other teachers, though.

[What I really like about science]...I think that when teachers try and especially work individually and, I don't know, if a teacher makes you feel that you are important--you know, I will take the time with you. You know, it's not like well you're gonna flunk. Oh well. And I think a lot of times students just get this mental block that, you know, they just can't do it and I think teachers, when they take time out to help, it really works.

I hated [sixth grade] science class. I think it was the teacher. He sort of didn't know much about it and he just sort of made it boring.

I like [him]. He's a really good teacher because he explains things really well but he makes it really fun. Just the way he talks about it. He kind of talks it up, you know. Doesn't make it sound like something you have to do but he makes it sound like something you want to do, like something you want to learn about.

Modes of Instruction

Students' attitudes toward classroom science also seemed influenced by the mode of instruction used by their

teachers. As with comments made about school in general, students' comments about classroom science again indicated they liked cooperative learning and hands-on activities. Generally, they did not like "passive" learning, such as taking notes or reading from the text.

I like experiments and not just book things. I think everybody would like that a lot better.

I hate [classroom science] because it is boring and it takes too long, reading the chapters out and stuff...There's nothing really that is exciting. He says a word like a name or something and you have to find the name in the book. That's mainly what we do. That's boring.

I don't really like science reading out of the book. I like experiments.

When we're taking notes in biology and just sit there and about falling asleep--when is this class gonna get over with? In biology, I would have more labs and stuff, hands on stuff.

I don't like not being in groups. I like groups cause you all get to work together and share answers and stuff.

I like doing labs and stuff...They're kind of like reality. It shows us really what things do and how they do them and stuff.

Relevance of Subject Matter

As noted earlier, most students did not see a reason for learning science unless they planned to be scientists. This sentiment came out not only in the direct question concerning the importance of what they were learning in science, but at other points in the interview as well.

Because unless you want to be a scientist you really don't have to use science.

I don't know [if science is useful outside of school]. I never thought about being a scientist.

Science, I don't think it will really help me a whole lot outside of school, but I don't know. I know that stuff, but I don't think it's gonna help me a whole lot for what I'm gonna do...I mean, of course, if you get into some jobs that's related to science and stuff, that'll help you. But I hope I won't be doing anything to related to science. I don't think I will.

Well it depends on like what your occupation is. If I was a scientist then it would. Doesn't it have to do with math a little bit? If you're a teacher you probably would have to do it. But not in everyday life.

A small number of students did feel that what they were learning in their science classes had meaning for them outside of school.

Yeah. Some things to, like, know what it is because if you talk about it at school and go out and see something or you know how it works it kind of makes you feel good because you know how that it works.

Things like about fungus and moss and things that grow on things, and when you go camping you can find it, and you didn't think you could find it there, but you look and you can find it.

...I want to be a movie director when I grow up and I will probably have to figure out a lot of the, uh, like for a lot of the special effects, you probably have to know what to put into them and stuff and the right calculations for like the ways, and camera shots...

Yeah, in everyday, really. Like you see something--an animal or something--you know what it is, what it does. You just know more about your surroundings and stuff.

It also makes me more aware of like environmental problems and things like that. It makes me more aware of what's going on and so a lot of time I will, you know, help out with

things like that which I probably wouldn't if I hadn't learned about it and stuff.

Science Background

Many seventh and tenth graders indicated they had had little exposure to classroom science in the elementary grades. Some of the fifth graders also expressed this sentiment. From the students' comments, the amount and type of classroom science a student was exposed to in the primary grades was more dependent on individual teachers than the school or district. Students freely used teachers' names when discussing their classes, and their comments indicated that some teachers (especially at the fifth and seventh grade levels) used laboratory activities more heavily while others relied primarily on book and/or seat work.

We didn't do much science. I kinda didn't like it. Where's all the science? I want to learn!
(Fifth Grader)

A lot of teachers don't spend a lot of time in science in the grade school. When you get up to a junior high you have to take science as a course, but sometimes they don't spend a lot of time on it and so you don't get the basic facts. You just kind of get a little bit, so you don't know very much and you don't learn very much. Of course, I had teachers who spent a lot of time on science. (Fifth Grader)

I only did [classroom science] one year. The first time I came in I didn't know what was really science...It was ok I guess for not really knowing about it. If I know a lot about the subject I like it a little bit more...I don't got much science background. (Seventh Grader)

[I like science] cause I don't really know that much about it...but in science I don't really know that much about what we're learning so it's all new. (Tenth Grader)

I just remember going to colleges and high schools when I was in second or third class. We'd go to college or high school every week, which I thought. I used to take astronomy classes in college. That was fun. (Tenth Grader)

In summation, based on the students' comments, students' attitudes toward classroom science were affected by their teachers, modes of instruction, amount of previous instruction, and relevancy of subject matter. Tenth graders also felt that achievement was linked to their attitudes toward classroom science.

CHAPTER V. DISCUSSION AND CONCLUSIONS

Introduction

The purpose of this study was to examine fifth, seventh, and tenth graders' attitudes toward school and classroom science by means of questionnaires and interviews. In particular, the study hoped to determine (a) whether a relationship exists between these two attitudes, (b) what relationship, if any, grade level, gender, ethnicity, school/community type, expected GPA and/or science grade, and personally satisfying GPA and/or science grade have with either or both of the attitudes, and (c) the source of students' attitudes.

The results indicated that a statistically significant relationship did exist between students' attitudes toward school and toward classroom science. In addition, all the variables with the exception of ethnicity and personally satisfying science grade were related to either or both of the attitudes at one or more of the grade levels. Finally, students from all three grade levels sampled had definite feelings about school and classroom science, particularly about modes of instruction, relevancy, their teachers, and the effect of attitude on achievement.

Interpretation and Discussion of Questionnaire Results

Most of the relationships examined in this study were found to be statistically significant. The large sample size impacted the statistical values required for significance in that the larger the sample, the smaller the r value required for statistical significance.

Since what constitutes an acceptable coefficient can be debated, what should be the more important factor in deciding the strength of a relationship is the practical, rather than statistical, significance shown by the relationship. Therefore, the results of the questionnaires in this study will be discussed in terms of both their statistical and practical significance.

Relationship between Attitudes toward School and Science

The first research question concerned the possible relationship between students' attitudes toward school and toward classroom science. In general, students' attitudes toward school were positive at all levels. Students' attitudes toward science were rather neutral. (A "perfect" undecided score would have been 69/115; answering "agree" on all questions would have yielded a 92/115.) Although the results showed the two were significantly related, with coefficients ranging from .33-.52, the practical significance of this finding is questionable. This weak relationship is in line with the

findings of Haladyna and Thomas (1979) and Talton and Simpson (1986). Many of the factors that students indicated affected their attitude toward school also affected their attitude toward science. Because of this overlap, some relationship ought to exist between the two. Because the relationship is weak, and because students already possess positive attitudes toward school, it would seem unlikely that using a more global, school-wide approach in an attempt to change students' attitudes toward science would be fruitful.

Relationships among Grade Level and Attitudes

Grade level was found to have a significant relationship with both attitudes toward school and attitudes toward science. Fifth graders were found to possess more positive attitudes toward school than seventh graders and tenth graders. However, the mean differences between the fifth graders' school attitude scores and those of the upper level students ranged from 1.45-2.70. While statistically significant, the actual differences in the scores between grade levels were not of any practical value. The means for each grade level for both questionnaire administrations indicated the students possessed positive attitudes toward school, contrary to the findings of Jaus (1977) and Berliner and Casanova (1985), who indicated students' attitudes decline with

increasing grade levels. However, the findings of this study did match the results of other studies (Berk, et al., 1970; Jackson & Lahaderne, 1967; Newfield & McElyen, 1983) which indicated students' attitudes toward school were positive at the elementary, middle, and high school levels.

Fifth graders were also found to be more positive toward science than the seventh and tenth grade students. Here the mean differences ranged from 8.30-14.66. These differences appear significant from both a statistical and practical standpoint. Because the same students were not followed and tested in their respective fifth, seventh, and tenth grade classes, the conclusion that as a student progresses through school, his/her attitude toward science declines is not warranted. However, many other studies have found this same trend (Ayers & Price, 1975; Finson & Enochs, 1987; Simpson & Oliver, 1985, and others).

In the past, researchers have highlighted and speculated on the reason for the decline in attitudes toward science between the elementary and the middle school grades. This study's interview data provided some possible clues for this drop. A question that has not been addressed in the literature is the reason fifth graders do not possess positive attitudes toward classroom science. In this study, the mean science attitude scores for fifth graders were 75.96 for the first survey

administration and 77.58 for the second. On a scale ranging from 23-115, this score placed them in the range of "undecided," albeit on the side closer to having a positive attitude. This finding was not unlike those in previous studies; for example, in the study by Harty and Beall (1984) the mean score for fifth graders was 65 on a scale ranging from 20-100. Again, the interview data provided some insight into the low scores: students felt they did not have much science in the elementary grades and most of their exposure to science was not process oriented. Some did not feel they had the science background needed for middle school science.

Relationships among Attitudes and Gender

Gender was found to be significantly related to students' attitudes toward school for all three grade levels. In each case, females possessed a more positive attitude than males. This result has been a common finding in previous studies, as well (Berk, et al., 1970; Darom & Rich, 1988). However, at least for this study (no descriptive statistics for other studies could be found), this difference in school attitude resulting from gender was of no practical significance. For fifth graders, females' mean scores were between 2.26-2.29 points higher than their male peers. Seventh grade females scored between 2.18-3.04 higher; and female tenth grade students,

1.40-1.68 points higher than male tenth graders. Given that the school attitude scale ranged from 10 to 50, these actual differences in mean scores between the genders did not seem to have any practical meaning.

A more interesting finding was that gender differences were not related to classroom science attitudes. Generally, males have been found to possess more positive attitudes toward science than females (Kyle, et al., 1986; Simpson & Oliver, 1985; and others). This finding did not appear to be the case with this sample. The only incidence of gender being a significant predictor variable was for the analysis of the first questionnaire administration, using science as the dependent variable and ethnicity, school/community type, expected GPA and science grade, satisfying GPA and science grade, and gender as the independent variables. In that instance, gender accounted for 1% of the explained variance. The actual mean difference was .66, and females possessed the higher score! The meta-analysis done by Steinkamp and Maehr (1983) also indicated an overall lack of a gender difference, and that females tended to like biology and chemistry more than males. It was encouraging to see that the gender difference toward science may be on the wane.

Relationship Among Attitudes and School/Community Type

Three school/community types participated in this study: urban, small city, and rural. No relationship was found to exist between students' attitudes toward school and school/community type at any grade level. This finding paralleled the finding by Berk, et al. (1970) that socioeconomic status of the students was not related to students' attitudes toward school.

Significant relationships were found between students' attitudes toward science and school/community type for both seventh and tenth graders. No such relationship was found with the fifth grade sample. Although school/community type accounted for 1% to 4% of the explained variance in seventh graders' science attitudes, Scheffe tests indicated that no two locations were significantly different at the .05 level. In addition, this variable was found to be statistically significant only with the data for the second administration. These factors suggest that school/community type is not related to seventh graders' attitudes toward science.

For tenth graders, school/community type was found to account for between 2% to 3% of the explained variance of students' attitudes toward science. Scheffe tests showed that tenth graders from the urban school possessed more positive attitudes than those in both rural and small city

schools (mean differences = 8.24 and 6.05, respectively) for the first administration and just the rural students for the second administration (mean difference = 10.62). Although the mean differences between the urban and rural schools seem to suggest a practical significance, several factors must first be considered. For one, an inconsistency in this relationship between school/community type and science attitude existed. Why did the urban students possess more positive attitudes than the small city students the first time but not during the second administration? Second, if school/community type does have a relationship with students' science attitudes, the same relationship should be evident at all grade levels. This was not the case. Therefore, the relationship shown between school/community type and students' attitudes toward science may more likely have been the result of the actual science programs at the differing schools rather than the schools' locations.

While other studies sampled students from varying community types, the relationship between that variable and attitudes toward science was not examined. A meta-analysis by Kremer and Walberg (1981) showed students of higher socioeconomic homes had more positive science attitudes and interests than those from lower socioeconomic families; however, the relationship was weak ($r = .17-.35$). As with attitudes toward school, students'

attitudes toward science are apparently not strongly related to school/community types.

Relationship among Attitudes and Expected GPA

Since fifth graders were not asked to report their expected GPA and science grade nor the GPA and science grade they would be satisfied to receive, the discussions concerning these variables are limited to the seventh and tenth graders in the sample.

For both the seventh and tenth graders, expected GPA was not found to be significantly related to science attitudes, but was found to have a weak relationship with attitudes toward school. Expected GPA accounted for 3% to 9% of the explained variance in seventh graders' attitudes toward school. In the first administration students expecting to receive a 4.0 were more positive than those expecting a 1.0 (mean difference = 6.52). For the second administration, those expecting a 1.0 were less positive than those anticipating a 4.0 or a 3.0 (mean differences = 9.94 and 7.63, respectively). In addition, those expecting a 2.0 were less positive than those anticipating a 4.0 (mean difference = 4.62).

With the tenth graders, expected GPA accounted for 5% to 10% of the explained variance in students' attitudes toward school. For the first administration, those expecting a 4.0 were more positive than those expecting a

3.0, 2.0, or 1.0 (mean differences = 2.43, 5.74, and 10.18, respectively). In addition, those expecting a 3.0 were more positive than those anticipating a 2.1 or 1.0 (mean differences of 3.31 and 7.75, respectively).

The second administration provided slightly different results. Those expecting a 1.0 were significantly less positive than those expecting a 2.0, 3.0 or 4.0 (mean differences = 8.81, 10.59, and 12.44, respectively). In addition, those expecting a 2.0 were less positive than those anticipating a 4.0 (mean difference = 3.63).

Some of the mean differences appeared to have practical significance. A relationship may have existed between school achievement and attitudes toward school. However, this statement does not suggest that those who do well in school like school and those who do not do well do not like school. Seventh graders expecting a 4.0 had mean school attitude scores of 41.40 and 41.27 for the two administrations, indicating they definitely had a positive attitude toward school, but not strongly positive. (Recall the scale was from 10-50, meaning responding "agree" to all statements would yield a score of 40 while consistently responding "strongly agree" would net 50 points.) Likewise, those seventh graders expecting a 1.0 had mean school attitude scores of 31.33 and 34.88, indicating they were undecided as to how they felt about school.

Tenth graders' scores paralleled those of the seventh graders. Students expecting a 4.0 had mean scores of 41.63 and 40.94, while those expecting a 1.0 had scores of 28.67 and 28.50.

Although a correlation did appear to exist between attitudes toward school and expected grade point average, it was not a strong relationship. (Pearson product-moment correlation coefficients for the seventh grade data were .17 and .31; and for the tenth grade data, .27 and .32) In addition, a significant difference did not exist between each of the GPA levels, further illuminating a weak relationship. Jackson and Getzels (1959) also found no link between student achievement and attitudes toward school. The question of the relationship between achievement and attitude still remains unanswered, especially since students mentioned the existence of such a relationship in their interview comments.

Relationship among Attitudes and Personally Satisfying GPA

For the seventh grade sample, personally satisfying GPA was found to account for 1% of the variance in the students' attitudes toward school in the first administration. An ANOVA performed on the data [$F(3, 196) = .88, p < .45$] indicated this variable was not significant. In an attempt to further explore this variable, the students' personally satisfying GPAs were subtracted from

their self-reported GPAs. These differences were then correlated with attitudes toward school. Product-moment correlation coefficients were weak, .05 and .22 for the first and second administrations, respectively. In conclusion, for the seventh graders, no relationship existed between attitudes toward school and personally satisfying GPA.

Analysis of the tenth grade data indicated personally satisfying GPA accounted for 4% of the explained variance in students' attitudes toward school in the second administration. Students satisfied with a 4.0 had more positive school attitudes than those satisfied with a 1.0 or 2.0 (mean differences of 10.35 and 4.62, respectively). In addition, those satisfied with a 3.0 were more positive than those satisfied with a 1.0 (mean difference of 8.99). As with expected GPA, although the mean differences appeared to be of practical significance, the statistical relationship was weak. Again, no significant differences existed between each of the personally satisfying GPA levels. Personally satisfying GPA did not appear to be a strong predictor of attitude toward school. The differences between students' expected GPAs and their personally satisfying GPAs were correlated with attitudes toward school. The relationship was weak, with correlation coefficients of .04 and .06 for the two administrations.

Personally satisfying GPA was not found to have a relationship with students' attitudes toward science at either of the grade levels. No other studies were found that examined the relationship between these variables. Based on this study's findings, however, looking at achievement from the perspective of what students would be pleased to earn or looking at the difference between what they would be satisfied with and what they actually received offered no clearer explanation of the possible relationship between achievement and attitude.

Relationship Among Attitudes and Expected Science Grade

Expected science grade was shown to be related to tenth graders' attitudes toward school for the second survey administration, accounting for 1% of the explained variance with school as the dependent variable and gender, school/community type, expected GPA and science grade, personally satisfying GPA and science grade, and ethnicity as the independent variables. A Sheffe test showed that those expecting to get an "F" in science were less positive than those expecting to get a "B" or an "A" (mean differences = 7.04 and 7.55, respectively). Although the accounted variance was negligible, the actual mean differences were large enough to dictate a closer look.

At first glance, a practically significant relationship may exist between science achievement and tenth graders' attitudes toward school. However, as with expected GPA, the conclusion that those who do well in science like school and those who do not do well do not like school cannot be made. Tenth graders expecting an "A" had a mean school attitude score of 40.48 indicating they had a positive, although not strongly positive (i.e. a score of 45-50), attitude toward school. Likewise, those tenth graders expecting an "F" had a mean school attitude score of 32.93, indicating they were undecided as to how they felt about school. Additionally, given the mean difference between those students expecting an "A"

and a "B" was .51, expected science grade did not appear to be a good predictor of attitude toward school. The relationship was found to be significant only with the regression model that included all the variables and only for the second set of questionnaire data. No relationship existed between seventh graders' expected science grade and their attitudes toward school. No other studies were found which compared these variables. Based on only one set of mean differences, a reliable relationship cannot be assumed to exist between expected science grade and attitudes toward school.

A relationship was also found between expected science grade and science attitudes for both seventh and tenth graders. For seventh graders, expected science grade accounted for 4% to 14% of the explained variance in students' attitudes toward science; for tenth graders, it explained 4% to 12%. While these correlations were not strong, the mean differences were worth examining.

For the first questionnaire data, seventh graders expecting an "A" were significantly more positive than those expecting a "C," a "D", and an "F" (mean differences of 14.33, 25.94, and 28.39, respectively). Students expecting a "B" were also significantly more positive than those expecting a "D" or "F" (mean differences = 15.51 and 17.96, respectively). For the second administration, those seventh graders expecting an "A" in science were

significantly more positive than those expecting a "D" or "F" (mean differences = 16.98 and 25.94, respectively).

Concerning the tenth grade data, those expecting an "A" in the first administration were significantly more positive than those expecting any other grade (mean differences ranged from 9.09 to 26.12). For the second administration, no significant differences were found among expected science grade with respect to science.

As with expected GPA, the data were confusing. The mean differences appeared to be high, but they were not consistent from administration to administration. For the second administration (which was just prior to the end of the term) the students may have had a more realistic idea of what grade they expected to receive, causing the inconsistency. Again, significant differences did not exist between each possible letter grade. Those students expecting to receive a "F" do not strongly dislike science; those students expecting to receive an "A" do not strongly like science. Other studies (Schibeci, 1983; Willson, 1983; and others) have found a weak relationship ($r < .30$) between science achievement and students' attitudes toward science. The relationship between expected science grade and attitudes toward classroom science is questionable.

Relationships among Attitudes, Personally Satisfying Science Grade and Ethnicity

No significant relationships were found to exist between personally satisfying science grade and either attitudes toward science or attitudes toward school. The differences between expected science grade and personally satisfying science grade were correlated with attitudes toward classroom science. The resulting correlation coefficients for the first and second questionnaire administrations were low: .18 and .14 for seventh graders and .17 and .05 for tenth graders. These coefficients provided further evidence of a lack of a significant relationship between personally satisfying science grade and attitudes toward science. No other studies were found that examined the relationship between these variables. Based on this study's findings, however, looking at science achievement from the perspective of what students would be pleased to earn or looking at the difference between what they would be satisfied with and what they actually received offered no clearer explanation of the possible relationship between students' science achievement and students' attitudes toward science.

Likewise no significant relationship was found between ethnicity and either of the attitudes. However, that given the sample was predominantly caucasian, it would be difficult to determine whether ethnicity was

indeed a predictor variable of either attitude. Some studies have found ethnicity to be a factor that affects students' attitudes (for example, Hall, Merkel, Howe, & Lederman, 1986), while others have not (for example, Schibeci & Riley, 1986). The possibility of a relationship between students' attitudes and ethnicity needs to be explored further.

Interpretation and Discussion of the Student Interviews

Factors Affecting Students' Attitudes toward School

The majority of the students interviewed felt positive about school. This finding supported the questionnaire results. While all students felt that schooling was important for their education, career opportunities, and/or future, some students questioned the need to study certain subjects. Based on the students' comments, most of the teachers were not making an attempt to explain why the material was important for the students to be exposed to or using relevant examples in their lessons.

Most of the students interviewed made some comment about attitude toward school or particular classes and achievement. Intuitively, a relationship should exist; however, correlational studies have not shown a relationship of any magnitude between these two variables. Given the students volunteered the link between attitudes

and achievement (i.e., they were not in response to specific questions about such a relationship), the lack of a statistical relationship is puzzling.

Tenth grade students appeared to be more concerned with the social opportunities afforded them by attending school than students in the two lower grades. While some fifth and seventh graders made reference to having/making friends at school, socializing was tantamount to tenth graders. The importance of socialization on tenth graders was also evident when the students spoke about who they felt would influence their attitudes toward school. Only tenth graders volunteered that their friends' attitudes would affect their own.

The reasons for the greater emphasis on socialization by the tenth graders interviewed are speculative. Tenth graders may be at a stage of development where peer relations are increasingly important. Also, high schools tend to offer more opportunities for students to socialize than the lower grades: school dances, clubs, sports, pep assemblies. In addition, since students have a more varied class schedule in high school, they may also have greater opportunities to meet with different groups of students; wherein grade school and to a lesser degree, middle school students tend to remain in the same group for each of their classes.

Teachers appeared to play a role in affecting students' attitudes toward school. While "teacher" was mentioned by all three grade levels as someone who wanted students to like school, not all groups indicated that teachers would actually influence their attitudes. In fact, no seventh grader mentioned "teacher" in the category of influences. This omission may have been due to the wording of the questions. The students were asked who would want them to like or dislike school and whether those people influenced how the students felt. Perhaps the students should have also been asked, "Who do you think influences how you feel about school?" Nevertheless, throughout the interviews, students repeatedly said they liked or disliked subject areas based on the teachers the students had, mentioned a teacher they liked or disliked, and indicated the students changed their attitudes due to a specific teacher.

From the students interviewed, teachers do indeed appear to help shape a student's attitude. However, that effect was not always permanent. For example, a student might have hated school one year because of a particular teacher, but liked it the next because he/she liked his/her present teacher.

No person or group was consistently identified by students as being someone who wanted them to like or dislike school and would influence students' attitudes

toward school. The theories of Reasoned Action and Planned Behavior incorporate influential others in their listing of predictor variables. Given the incongruity of the teacher variable comments, when presented with a specific person or group to comment on, students may indicate they are indeed influenced by these people. However, when just asked to name who they felt would affect their attitudes, this was not the case. Again, the change in wording indicated previously might have made a difference.

An area all students felt strongly about was how they preferred to be taught. When commenting on experiences they liked or disliked in school, factors that changed or would change how they felt, and what they would change about school, the responses of the students were consistent. Students at all grade levels preferred active rather than passive instructional modes. Students wanted more hands-on activities, opportunities for cooperative learning, and group discussions. They wanted less book reading, note taking, and listening to lectures. Since this is what is typically advocated in teaching methods books (Collette & Chiapetta, 1984; Gega, 1990; and others), the preparation of teachers happily meshes with what the students would enjoy. Unfortunately, at least from the students' perspectives, teachers were not often

implementing these modes of instruction in their classrooms.

Simply changing the type of instructional activities employed in a classroom will not necessarily in itself change students' attitudes. Even though the interviewed students requested these instructional methods, their disuse did not create negative attitudes in most of the students.

Factors Affecting Students' Attitudes toward Science

Many of the variables that were found to affect students' attitudes toward school also appeared to be important in the determination of students' attitudes toward classroom science. As compared with school, fewer students felt there were persons or groups who wanted them to either like or dislike classroom science. Even fewer students felt anyone's feelings had an influence on their own. One might question the existence of a pattern between the amount of influence significant others have on students' attitudes and the "positiveness" of those attitudes. That is, do students have a more positive attitude toward school than science because there are more people students feel want them to have positive school attitudes? This supposition would follow the reasoning of both the Theory of Reasoned Action and the Theory of Planned Behavior.

The interview data provided further fuel for this argument. Students whose comments indicated they felt strongly positive about classroom science tended to mention particular teachers whose science class they enjoyed and science-related activities done at school and/or home. The latter included activities such as reading "science" books, using microscopes and telescopes, making mobiles from leaves, going to a science museum,

watching National Geographic, and other activities. For example, one student noted

My mom knew I liked science because I used to watch science shows when I was really little, and soap operas. So she kind of got me into the habit of doing experiments...

The amount and type of science experiences a student is exposed to throughout his/her development may affect that student's attitude toward science.

Some students complained about not having enough science in school or having an inadequate background in science when they enrolled in their first science course in middle school. This lack of science exposure may explain some of the confusion and misconceptions some students vocalized during the interviews. For example, one student thought science was about making bombs; another liked science but not health (they were studying digestion in health). One seventh grader said she had seen the "afterbirth thing" of a squid and was anxious to dissect a "pregnant" frog. A seventh grader who did not like science and did not think there was any reason he should like science wanted to become a veterinarian! When asked about the discrepancy between his attitude comments and his future career choice, he explained "I know more about animal science and veterinarian science. I don't know much about regular science."

This lack of a strong knowledge base and influential sphere may also explain why many students felt what they

learned in science class was not relevant to their everyday lives. Some students were able to give examples showing how science content could be applied. However, given the wide range of science topics the students had been exposed to and the limited number and type of relevant examples students could give, the question of how many of the teachers were attempting to address the question of relevancy in their teaching remains.

An easy way to incorporate relevancy into science lessons is through Science, Technology, and Society (STS) education. Although the National Science Teachers Association (NSTA) published a position paper on STS in 1982 and many funded efforts to get STS implemented in the schools have been and are in existence, little progress on this front has been made. A recent survey by Waks and Barchi (1992) indicated that while most science teachers know what STS stands for, they do not know what to do with it in their classrooms. While the STS movement is not a panacea for improving science curricula, it is an important step.

Two other factors students mentioned concerning their attitudes toward science were their teachers and the modes of instruction used by their teachers. Often times, these two were intertwined in the students' comments. As with the comments students made concerning how they would like school to be taught, almost all the students interviewed

felt their teachers should teach using more hands-on activities. An increase in field trips was also a popular suggestion. Cooperative learning and discussions were favored by students. Generally, students disliked note-taking, reading from the book, and listening to lectures. These feelings paralleled their comments about why they liked or disliked science and what their most favorite and least favorite experience in science class were. Hands-on activities and field trips were positive responses, while "boring" classes or activities were typical negative responses.

Many of the students described the ways they saw science being taught in their classrooms. The teachers seemed to be the key rather than the particular school or district. Some fifth grade teachers did experiments and demonstrations and brought in examples and pictures for their students to see and handle. Others did no experiments and relied on reading from the text. The same was true for seventh grade teachers. According to the student reports, some did experiments, brought in examples for students to see, and so forth, while others relied on worksheets, reading from the text, and lecturing. One seventh grader described her sixth grade science class. (She was not enrolled in science during the term she was interviewed.)

Well, last year because of the way we did it, it was really fun. We had packets and we had notes

on the board. We had to copy down the notes and so some worksheets and put them in our packets and decorate the covers of our packets for prizes. You win prizes for the best decorated packet put together and stuff.

All the tenth grade teachers used laboratory activities and group work. The tenth graders complained they wanted more of these types of activities.

Science methods books for both secondary and elementary teachers stress that science is both content and process. Therefore, it seems surprising some fifth and seventh grade teachers apparently viewed science teaching as presenting only a body of knowledge. However, other researchers have shown that this teacher view is not an atypical occurrence (Shymansky, Yore & Good, 1991).

Another concern is the limited amount of classroom science to which many fifth graders had been exposed. One common explanation for the "hit and miss" exposure of elementary school children to classroom science is that the elementary teachers do not have an adequate science background and therefore do not feel comfortable teaching the subject. In 1983, NSTA proposed a set of standards for the science content preparation of preservice elementary teachers. The NSTA guidelines suggested preservice elementary teachers be required to take 12 semester hours of laboratory or field-oriented science specifically for elementary teachers (to include biology, physical science, and earth science) and three semester

hours of elementary science methods. A recent survey by Tolman and Campbell (1992) of institutions belonging to the American Association of Colleges for Teacher Education showed that the NSTA guidelines for course work were not being met by most of the responding institutions. However, the majority of the schools were requiring their preservice elementary teachers to have an elementary science methods course. It appears that science instruction at the elementary level will improve.

Researchers have studied the relationship between attitudes toward science and science teaching method. These findings have been inconclusive. Studies by Kyle, et al. (1986, 1988) and Jaus (1977) found student-directed approaches (vs. teacher-directed) helped to make students' attitudes more positive. Vanek and Montean (1977) found that the type of science instruction did not affect students' attitudes toward science. Gilbert's (1989) study examining the use of analogies in science teaching also provided inconclusive results.

Achievement was implied by students to be linked to their attitudes toward school. A corresponding relationship between achievement and attitude toward science was only voiced by some of the tenth graders that were interviewed. Since the question of the possibility of a relationship existing between attitude and science achievement was not presented to the students, one cannot

say that the others did not feel such a relationship may exist.

A final question that remains to be answered is why fifth graders' attitudes toward science were significantly more positive than those students in the seventh and tenth grades. Hopefully, given the depth of their science content background and science education preparation, middle and secondary science teachers should be better prepared to teach science than elementary teachers. Since several studies have shown that teachers do have an effect on students' attitudes (Brunkhorst, 1988; Haladyna, et al., 1982, 1983), the students in the upper grades should possess more positive attitudes toward science. However, this conclusion is not supported by research. James and Smith (1985) and others have suggested that students' attitudes toward science decline in the upper grades was due to the course being required and graded. This suggestion remains a possibility.

Coupling the questionnaire data with the interview data from this study suggests that several factors may be at work in shaping seventh graders' attitudes toward science. (Since the same students' attitudes were not assessed in fifth, seventh, and tenth grades, these comments are purely speculative.) First, fifth graders did not possess positive attitudes. They were undecided as to how they felt about science classes, though they did

lean to the positive side. Nothing seems to have been done to sway them to develop positive attitudes.

From what the students said, the science background the students received in elementary school was quite varied. Most had limited exposure to either science content or science activities. Apparently, much science learning came from reading science textbooks. Students were not made to think about what they were reading, question it, discuss it. The role of their parents in encouraging students to enjoy science was questionable. The students then moved onto middle school.

The students were in a new, possibly unfamiliar school. They might be with different groups of peers. The science teacher was following the state or district curriculum. Because of the varied backgrounds of the students, some had trouble understanding the material while others were bored from the repetition. To some, laboratory activities were foreign and scary. They may not have understood the material and thus had trouble making sense of the laboratory work. Likewise, some teachers continued to teach almost exclusively from the textbook and the students remained passive "learners."

Attitudes can change. What stimuli have the students been exposed to that would make them feel positively toward classroom science? The data suggested that the amount and type of science exposure a student had (whether

it be at home or school) may have affected a student's feelings toward classroom science.

This pessimistic accounting does not suggest that all parents, teachers, and schools are doing a terrible job in teaching science. Even though they all offered ways to improve science class, most of the students interviewed said they enjoyed studying science. As one fifth grader said

I think that science is fun, entertaining, and educational because you always get a little fun in science, you always get lots of education, you always get excitement, and you always get to learn something new every time. Even though you might have to review sometimes, you'll always have something interesting, new to learn.

Limitations

A number of factors limited the generalizability of the findings of this study. The first was the sample. Because only school districts, and then individual students who were willing to participate in the study could be used, the sample was not sufficiently broad to represent all student populations. For example, no inner city school students were included. Another limitation was the amount of cooperation from the individual teachers in the participating districts. While the administrators noted their willingness to cooperate, not all the effected teachers in their schools were. Consequently, not all

students in the selected schools were given an opportunity to participate in the study.

In addition, the sample was primarily caucasian. While this predominantly white sample was not unexpected given the demographics of Oregon, the generalizability of the results is limited to a similar population.

The students' honesty in answering the questionnaires is another limiting factor. While safeguards were used to ensure the confidentiality of the students' responses, an assumption must be made that the students' responses were true indicators of their feelings.

Several limiting factors existed with the interviews. Most of the students interviewed possessed positive attitudes toward science. Interviewing students with a wider range of attitudes would have been preferable. As noted earlier, the final selection of interviewees was determined by the school administrators. Perhaps, rather than presenting the administrators with a prioritized list, three lists could have been prepared: one for strongly positive, one for very negative, and one for undecided/changed attitudes toward science. The principals could have been directed to choose one student from each list, giving the administrator flexibility in choosing a cooperative student and still providing for a range of attitudes in the interviewees. Also, the responses of the students were limited by: the ability of

the students to express themselves, particularly to a stranger; the honesty of their responses; and the skill of the interviewer.

Finally, comments made about how teachers taught and the curricula were based solely on students' perceptions. No classroom observations were made nor were school district curriculum guides examined. In addition, the interview data suggested teachers had an effect on students' attitudes. Because the survey forms did not ask for identification of the students' teachers, no statistical analyses could be done using "teacher" as a predictor variable.

Recommendations

The area of attitude research in the field of education is still in its infancy. As students' attitudes continue to be examined, more questions are raised than are answered. However, attitude is an important area of concern, and continued efforts need to be directed to this concept to enable educators to instill positive attitudes in their students.

Attitudes have been described as being stable; that is, they remain unchanged unless something happens to affect a change. This study attests to that attribute. The mean differences in students' attitudes toward school and science between the two administrations of the

questionnaire were quite small. Future studies need not use repeat survey administrations over varying amounts of time to assess the relative stability of attitudes.

A longitudinal investigation of students' attitudes as they proceed through their schooling is clearly needed. A sample of elementary students could be given attitude questionnaires mid-year, followed by interviews. The students could be given questionnaires again at the end of the year, with follow-up interviews. This pattern should be repeated annually, providing data on whether students actually become less positive toward science during time, and if so, what factors cause the attitudinal change.

Another area that needs further attention is the effect of home experiences on students' attitudes toward school and science. A relationship appears to exist between these factors; however, this study was not designed to explore that connection. Parental involvement has been shown to be an important element in the schooling process (Northwest Regional Educational Laboratory, 1990). A study by Talton & Simpson (1986) showed family had an influence on students' science attitudes. An interesting question for consideration is: what impact does parental involvement and a student's home experiences have on the student's attitude toward science and how are these resources best utilized?

Gender was not correlated with students' attitudes toward science. Does this mean gender differences have disappeared or did they ever exist in Oregon? If they are evident elsewhere, what is happening in Oregon that is not occurring elsewhere that alleviated the "traditional" attitude toward science difference?

The question of attitude and achievement for both school and science remains unanswered. While some evidence suggests there is a relationship, statistical results do not exist. Is it that achievement really plays a minor role in how students feel about school or particular subjects or do researchers need to approach this question from a different angle? At the start of the school year, 2% of both the seventh and tenth graders expected to get a 1.0 GPA. Five percent of the seventh graders and 4% of the tenth graders expected to get either a "D" or a "F" in science class. While educators may be pleased that the large majority of students start the school year expecting a "C" or better, the fact that any student would expect to do poorly right from the start is disturbing. Past research has shown a link between subject-area feelings of self-concept and attitudes (Haladyna, et al., 1983; Simpson & Oliver, 1990; Talton & Simpson, 1986; and others). The reason for the "fatalism" of these students should be examined.

Finally, since some elementary teachers who feel comfortable teaching science, perhaps the schools can restructure teaching assignments to utilize the expertise. One fifth grade teacher, for example, might teach science to all fifth grade classes, while another might become a different subject specialist. This flexibility in teaching assignments would ensure students in the lower grades get a consistent exposure to science, and, hopefully, a more positive one.

Implications

Students' attitudes toward science leave much room for improvement. None of the grade levels sampled had positive attitudes toward classroom science. This lack of a positive attitude should be a major concern to science teachers and to science teacher educators. The question, of course, is: What can be done to improve students' attitudes toward classroom science? Two areas of concern mentioned by the students were the variety of teaching methods employed by their teachers and the relevancy of what they were to learn. Because both science teacher educators and students feel that hands-on activities are important instructional modes, the Theory of Planned Behavior may be applied to pre- and/or in-service teachers. Does the theory apply to those groups of people? Can the persons can be persuaded to want to

implement hands-on activities in their classrooms? A follow-up study of teachers' actions would also be warranted. The same could be done with persuading pre- and in-service teachers to incorporate STS and cooperative learning activities into their lessons. It would also be helpful to assess why in-service teachers may not be frequently employing these methods in their teaching. Of course, it would be necessary to see if varying instructional modes and incorporating STS in the curricula do indeed affect students' attitudes.

Based on the students' interview responses and past research (Brekelmans, Wubbels & Creton, 1990; Simpson & Oliver, 1990, and others), the teacher is a powerful force that shapes students' attitudes. Unfortunately, many teachers were portrayed as being fairly static in their instructional approaches. Science teachers (both preservice and in-service) must be made to feel comfortable teaching both content and process oriented science. They need to know where to find activities, how to choose them, and the best way to implement activities in their classes. Science teachers also need specific directions and guidelines for incorporating STS ideas into their lessons. While most science teacher preparation programs keep current with the educational research, the programs must continue to stress not only resource access but, particularly, the integration of such

resources into the school curricula. Workshops should be conducted for in-service science teachers to make them aware of the recommended curricula changes, as well, and to provide guidance to the in-service teachers for implementing these changes.

Because of the type and limited amount of exposure the interviewed students in this study had to science at the elementary levels, the NSTA guidelines for the science preparation of pre-service elementary school teachers do not appear to be widely followed. Reasons for non-compliance should be examined; and, perhaps, the guidelines need to be reevaluated. Special workshops should be conducted (either during summer or evening classes in local colleges and universities and/or as special district-wide workshops) for in-service elementary teachers, to emphasize the need for process-oriented science in grade school and to provide them with the resources the teachers need to implement same. In any case, if the national goal of all students possessing a positive attitude toward science is to be met, middle school is apparently not the place to start.

The relationship between attitude and achievement remains unclear. Intuitively, such a relationship should exist. Students themselves indicate attitude and achievement are related. Statistically, no significant correlation between the two can be found. Perhaps too

many other factors affect achievement (for example, teacher expectations, parental influence and expectations, student self-concept, locus of control) for a single factor to emerge. Perhaps the ways researchers have attempted to measure students' achievement limit the resulting statistical analyses. Perhaps a strong relationship simply does not exist! If the latter case is true, the reason for the development of positive attitudes toward science among students as a national goal must be restated: it is to help ensure that all citizens are scientifically literate. AAAS (1989) defined scientific literacy as follows:

- being familiar with the natural world and recognizing both its diversity and its unity
- understanding key concepts and principles of science
- being aware of some of the important ways in which science, mathematics, and technology depend upon one another
- knowing that science, mathematics, and technology are human enterprises and knowing what that implies about their strengths and limitations
- having a capacity for scientific ways of thinking
- using scientific knowledge and ways of thinking for individual and social purposes. (p. 7)

Thus, scientific literacy transcends science achievement or grades received in science class or on science tests. Even if no relationship is ever found between science achievement and attitudes toward science, development of positive attitudes is still an important goal.

This study also provided a methodological implication for science education research. While the major science attitude researchers are advocating a move away from survey-type studies and toward persuasive attitude change techniques (Koballa, 1992; Shrigley and Koballa, 1992), surveys do have a place in attitude research. The common criticism that surveys are not accurate assessment tools does not apply to all instruments. The questionnaires used in this study, for example, were found to be both valid and reliable. The students' responses during the interviews meshed well with their survey responses. Careful use and selection of surveys can overcome that problem. In addition, future studies must continue to clearly define the specific attitude being measured.

While the critics are correct in saying survey studies do not lead to a wealth of avenues for future research, paper and pencil assessments are useful in a number of ways: identification of factors that may be important in shaping students' attitudes; a quick measure of what students' attitudes are; and a means of measuring the effect of an intervention program. Additionally, as with this study, surveys can serve as a good basis for follow-up interviews.

In summation, students' attitudes toward school seem healthy. Students' attitudes toward science do not. The relationship between students' attitudes toward school and

science is weak, indicating the problem of students' attitudes toward science is not a piece of a more global attitude problem. However, it is a problem in search of solutions. It is one thing to say teachers should teach in such a manner that their students' develop positive attitudes toward science. It is another to describe just what that "manner" should be. Several possibilities have been suggested from this research. Other studies have indicated both successful and unsuccessful intervention techniques. Some researchers are employing persuasion techniques. Hopefully, time, experimentation, and experience will eventually lead to a prescription for curing these "ailing" attitudes.

In this changing world where science and technology play such a major role, it is imperative that our citizens develop a healthy attitude toward science. Voters need to make decisions concerning scientific and technological advances, and they will not be able to make those choices if they think they cannot understand the topic or have a feeling of disregard for it. Besides, science is necessary for us to understand ourselves and our surroundings--and a little understanding goes a long way in enhancing appreciation.

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APPENDICES

APPENDIX A: Attitude toward School Questionnaire

1. I look forward to going to school each day.
2. I think it is important for me to go to school.
3. There are other things more useful to me than going to school.
4. What I learn in school will help me in the future.
5. I like being in school.
6. I think going to school is a waste of time.
7. I am happy when I am in school.
8. What I learn in school is worthless.
9. School is of value to me.
10. Even if I think there are better things to do than go to school, school is important.

APPENDIX B: Teacher Instructions, First Administration

Survey Administration Guidelines:

Thank you for administering the series of questionnaires. I appreciate your following the instructions listed below in giving the instruments to the students. It is imperative that you read the instructions exactly as they are presented in order to maintain a standardized administration of the survey to all students in all the schools participating in this study.

1. Read this introduction:

"Today you are being asked to fill out a questionnaire. This is a voluntary activity. Whether or not you choose to complete the questionnaire will not affect your grades nor will you receive or lose any special considerations from the school based on your participation in this study. One set of questions on this questionnaire deals with how you feel about school. A second set deals with how you feel about classroom science.

Please fill out the questionnaire honestly. NONE of your teachers here at the school will ever see your responses. You are being asked to fill out the survey to provide valuable information to a researcher concerned with how students feel about science class."

2. Pass out the sheets. The students need to use a number two pencil. Please direct the students to fill in their complete name (first and last), grade (5th, 7th, or 10th), gender, ethnic group, and (for 7th and 10th grade classes) to list any science courses they have taken, including any they may be presently enrolled in. It is important to the study that all this information be given. Please check that all the students have included the information on their sheets.

3. After everyone has the basic information filled in, please read the following:

"What you need to do is read the statement. Think about whether you agree with that statement. In the response section, darken the box that most closely shows how you honestly feel about the statement. The key for the boxes is printed across the top of the answer section. SD stands for strongly disagree; D is for disagree; U means undecided, that you're really not sure; A stands for agree; and SA means you strongly agree. Please refer to the key

when you are darkening the boxes to be sure you are marking the response you want.

When you are done with the front of the page, please turn the sheet over and complete the questions on the back. It is important for you to answer all the questions.

When you have finished the front and back of the questionnaire, please bring your sheet up and place it in this envelope." (Please hold up the response reply envelope.)

"After the entire class has completed the questionnaire, we'll seal the envelope. Then I'll have one of you take it to the office so it can be mailed to the researcher. That way you'll know that none of us will be looking at how you answered the questions."

4. Please see if anyone has any questions and answer them as best you can. If any students have questions concerning specific questionnaire items while they are answering the survey, please see what you can do to explain them. If in doubt, leave the question blank.

5. Have a student bring the envelope of completed questionnaires to the main office.

Thank you!

APPENDIX C: Teacher Instructions, Second Administration

Survey Administration Guidelines:

Thank you for administering the series of questionnaires. I appreciate your following the instructions listed below in giving the instruments to the students. It is imperative that you read the instructions exactly as they are presented in order to maintain a standardized administration of the survey to all students in all the schools participating in this study.

Please note that although this is the second (and last!) time the questionnaire is being given out, a student need not have filled out the first one in order to participate in this administration. I would appreciate your encouraging all your students to take the survey.

1. Read this introduction:

"Today you are being asked to fill out a questionnaire. This is a voluntary activity. Whether or not you choose to complete the questionnaire will not affect your grades nor will you receive or lose any special considerations from the school based on your participation in this study. One set of questions on this questionnaire deals with how you feel about school. A second set deals with how you feel about classroom science. You might remember that you filled these out earlier in the school year. It is important that you take the questionnaires again because repeating the survey will provide the researcher with more accurate information. Do not try to answer this questionnaire so it matches what you said the first time. Answer it so it shows how you feel today.

Please fill out the questionnaire honestly. NONE of your teachers here at the school will ever see your responses. You are being asked to fill out the survey to provide valuable information to a researcher concerned with how students feel about science class."

2. Pass out the sheets. The students need to use a number two pencil. Please direct the students to fill in their complete name (first and last), grade (5th, 7th, or 10th), gender, and ethnic group. It is important to the study that all this information be given. Please check that all the students have included the information on their sheets.

3. After everyone has the basic information filled in, please read the following:

"What you need to do is read the statement. Think about whether you agree with that statement. In the response section, darken the box that most closely shows how you honestly feel about the statement. The key for the boxes is printed across the top of the answer section. SA stands for strongly agree; A is for agree; U means undecided, that you're really not sure; D stands for disagree; and SD means you strongly disagree. Please refer to the key when you are darkening the boxes to be sure you are marking the response you want.

When you are done with the front of the page, please turn the sheet over and complete the questions on the back. It is important for you to answer all the questions.

When you have finished the front and back of the questionnaire, please bring your sheet up and place it in this envelope." (Please hold up the response reply envelope.)

"After the entire class has completed the questionnaire, we'll seal the envelope. Then I'll have one of you take it to the office so it can be mailed to the researcher. That way you'll know that none of us will be looking at how you answered the questions."

4. Please see if anyone has any questions and answer them as best you can. If any students have questions concerning specific questionnaire items while they are answering the survey, please see what you can do to explain them. If in doubt, leave the question blank.

5. Have a student bring the envelope of completed questionnaires to the main office.

Thank you!!